NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

"To the solid ground
Of Nature trusts the mind which builds for aye."—WORDSWORTH.

SATURDAY, JULY 5, 1924.

CONTENTS.

The Imperial Institute Bill.

A GOVERNMENT Bill to effect the reorganisation of the Imperial Institute has been introduced into the House of Lords by Lord Arnold and there passed its second reading. This Bill will be welcomed, as it should help the development of that Institute to a position worthy of the group of museums and scientific institutions at South Kensington. The Colonial Office Committee of Enquiry into the Imperial Institute in 1923 recommended the abolition of its galleries, the limitation of the work of its laboratories to preliminary investigations of raw materials, and the reduction of the Institute to a clerical bureau. This scheme was approved by the Imperial Economic Conference, some members of which were unacquainted with the facts, as one of them has since stated. If the majority report of the Colonial Office Committee had been promptly carried into effect, the Imperial Institute collections would have been scattered and the galleries occupied by a War Museum, which, however desirable, would have been out of place in South Kensington on a site allotted to the development of the industrial arts and science by the Commissioners for the Exhibition of 1851. The majority report of the Committee was opposed by a strong minority, and has since been widely condemned.

The Bill, in agreement with the minority report, is based on the retention of the Imperial Institute galleries and the amalgamation of the Mineral Resources Bureau with the Mineral Department of the Institute. The Bill proposes the transfer of the management of the Institute from the Colonial Office to the Department of Overseas Trade, which is a branch of the Board of Trade, and the establishment of a new Board of Governors consisting of representatives of the Dominion of Canada, Australia, New Zealand, South Africa, the Irish Free State, Newfoundland, and India,

and representatives of the Treasury, the Board of Trade, the Colonial Office, the Ministry of Agriculture and Fisheries, the Department of Overseas Trade, and the Department of Scientific and Industrial Research, and not more than ten scientific and commercial representatives, including one from the Royal Society and not less than three Governors of the Mineral Resources Bureau.

The property would be vested in six Trustees, all of whom would be members of the Government. As the Imperial Institute was erected and endowed largely by public subscription and its main service would be to the smaller colonies, it is desirable that some of the Trustees should be unofficial, and one of them should represent directly the Empire overseas. More confidence in this Board of Trustees would be felt if only three of them were members of the Government, and the other three included a representative of the Dominions, the president of the Association of the British Chambers of Commerce, and some such authority as the Governor of the Bank of England or the president of the Institution of Mining and Metallurgy.

The Board of Governors would act through a Managing Committee which would be aided by various advisory councils or committees, including one on minerals, and would be associated with a Laboratory Committee, including representatives of the Department of Scientific and Industrial Research and of the Royal Society.

This Bill renders possible the development of the Imperial Institute as a great museum and research institution for the investigation of the natural resources of the British Empire overseas. The reconstituted Institute might develop into an organisation capable of giving important help in the investigation of the economic geology and mineral resources of the Empire outside Great Britain. The Bill is, however, unsatisfactory in two respects in which the terminology of the abandoned majority report has passed into the Act. That report recommended the appointment of a Laboratory Committee, the functions of which would render the Institute laboratories futile. The Laboratory Committee, according to the resolution of the Imperial Economic Conference, was proposed "to ensure that the reconstituted Imperial Institute may in future undertake in its laboratories only preliminary investigations of raw materials for the purpose of ascertaining their possible commercial value. . . ." If any more extensive research or investigation be required, it would be the duty of the Laboratory Committee to see that the material were sent to some other authority in Great Britain or "elsewhere within the Empire."

This proposal would, if carried into effect, seriously lessen the usefulness of the Institute. Many of the most interesting materials it might expect to receive would be submitted in confidence, which would not be felt if the material were to be distributed to University or public laboratories for investigation. The various Departments of the Institute would doubtless include experts in some branches of its work, and they would sometimes have to send on material for investigation to people less competent to deal with it than themselves.

The scheme would probably also involve risk of trouble between the several committees of the Institute. The Managing Committee and the Mineral Committee would naturally desire to escape from the restriction to preliminary work, though ready to seek the co-operation of authorities who might be specially competent to deal with special materials or problems. The Managing and the Mineral Committees might therefore be in frequent friction with the Laboratory Committee, the duty of which would be to see that the other committees and the Institute staff committed nothing beyond an elementary commercial examination. The clause in the schedule enumerating the purposes of the Institute "To conduct preliminary investigations of raw materials and, when it may be deemed advisable, to arrange for more detailed investigation by appropriate scientific or technical institutions," therefore, might well be amended by omission of the word "preliminary" and the alteration of "more detailed" into "further" investigation.

The main discussion hitherto has been over the galleries, the great educational value of which has been frequently pointed out in NATURE. The new Bill empowers the governing body to maintain galleries for the exhibition of Empire products. If the Bill be passed as now worded, some future official might maintain that collections of commercial samples in the Dominion offices in different parts of London would satisfy this clause, and this Bill might be used to give effect to the very policy which it is understood that the Government at present in office has abandoned.

The schedule stating the purposes of the Imperial Institute does not even refer to the Institute galleries. The only clause dealing with collections states that the Institute is "to organise, so far as practicable, exhibitions of Empire products." This clause is quite inadequate as a statement of the duties of the Institute in connexion with its public exhibition galleries. It implies that all the Institute should arrange is exhibitions of commercial samples, which, as the Colonial Office Committee recommended, might be peripatetic.

The clause should be amended to state definitely that the Institute should retain its galleries at South Kensington and maintain in them exhibitions of the products of the Empire, so displayed as to demonstrate their nature and uses, and to illustrate adequately the geographical conditions and material resources of the British Empire.

A few amendments are therefore desirable to prevent ambiguity. Without these changes, there is the risk that the Act will, in effect, be used to return to the recommendations of the majority report of the Colonial Office Committee of Enquiry, and thus to prevent the Imperial Institute from fulfilling the important functions proposed for it by its far-seeing and generous founders.

The New Astronomy.

The Depths of the Universe. By George Ellery Hale. Pp. xv+98. (New York and London: Charles Scribner's Sons, 1924.) 7*s.* 6*d.* net.

ASTRONOMY is a subject which, in spite of the delicate refinement of its observations and the severe technicality of its mathematical processes, yields results which can be fairly apprehended by the general educated public,—results moreover which, though apparently far removed from humanity, yet invariably arouse a human interest. There was a time when it appeared to be a completed, so to speak, perfected science, in which little of a revolutionary character was to be expected. But modern discoveries in physics have changed all that; and discoveries are yearly being made which are likely to enlarge our ideas about the constitution of the heavens in a striking and revolutionary manner.

Part of this progress is due to the enthusiastic workers, and the great resources provided for them, on the other side of the Atlantic; where lavish provision has been made for experimental resources, where sufficient mathematical skill is available for devising methods and interpreting results, and where the clearness of the air on mountain-tops has been utilised after the enterprising manner characteristic of the American nation.

Among the workers in novel directions the name of George Ellery Hale is held in honour throughout the civilised world; and the whole world hopes for his restoration to health, so that he may continue to infect his co-workers with enthusiasm, and that he may have the joy of continuing the utilisation of the magnificent Observatory and laboratories on the top of Mount Wilson in California. Meanwhile he has been giving us the benefit of his powers of exposition in articles and discourses, some of which are being collected in small and illustrated books, one called "The New Heavens," and another, which has just been published, entitled "The Depths of the Universe." The main branches of the subject dealt with in this little volume are three in number. The first relates to the stars and star clusters, with some account of the remarkable and novel principles by which spectroscopic determination of excessive and otherwise hopelessly immeasurable distances can be made. The second relates to the nebulæ, and especially to the dark nebulæ discovered by the late Edward Emerson Barnard, of the Yerkes Observatory, whose lamented death has so recently occurred, and to whom the author pays an affectionate and admiring tribute. While the third chapter in the book gives further details about the author's own great discovery about the magnetic condition of the sun and its spots, a subject begun to be expounded in one of the chapters of "The New Heavens," and now carried to a further stage.

The treatment throughout is of a popular character, and all recent advances are linked on to the history of the past. Thus in the first chapter, which is specially on "The Depths of the Universe," Prof. Hale begins with Galileo and the first telescope, and carries the history rapidly forward, through Herschel, to the determination of stellar and globular-cluster distances by Dr. Harlow Shapley, of Harvard.

The main theme of the first chapter is the size and shape of our stellar cosmos, familiar to all as "the Milky Way," which must be of unexpectedly vast extent if the immensely distant globular clusters form any part of it. Outstanding questions about the spiral nebulæ are not dealt with; but many details are given about other objects, and especially the dark nebulæ emphasised by Barnard. Some of them are regarded as immense clouds of dust driven away by the pressure of light, but held together, even in diffuse form, by their own gravitation. It is suggested that many of the nebulæ are only luminous because they reflect, or fluoresce in, the light of luminous stars in their neighbourhood. This seems specially to apply to the great nebula in Orion. But the globular star clusters are of a different order, perhaps more analogous to the constellation of Orion itself, the great cluster or crowded and enormous constellation in Hercules being apparently at a distance of 36,000 light-years.

Incidentally I would here express a hope that the light-year, as a unit of stellar distance, may be generally employed instead of the less satisfactory parsec, as a cosmic measure. Distances can very properly be expressed in terms of speed and time: that is indeed the fundamental way of measuring them, and far superior to anything dependent on the copying of an arbitrary unit such as a yard or a metre. Parallax,

dependent on the length between earth and sun, is absurdly incompetent to express enormous distances: the period of earth's revolution combined with the speed of light is better. It seems impracticable to get away altogether from the earth, in devising a cosmic unit, but the periods of the earth's rotation and revolution are universal terrestrial units of time; while as to the velocity of light, it appears to be about the only absolute thing we know.

To return from this brief digression. In order to emphasise the enormous number of stars now accessible to photography, Prof. Hale gives an interesting series of photographs, with different exposures, of a small region in Auriga near a third magnitude star. The first exposure is long enough to show stars down to the ninth magnitude, but none are visible, only the big one. The second exposure would show twelfth magnitude stars, and there are now five or six on the plate. A further exposure, long enough to bring out those of the fifteenth magnitude, shows something like fifty in all. Exposing long enough for seventeenth magnitude stars, more than two hundred appear; and when stars of the eighteenth magnitude are allowed time enough to impress the plate, the field is crowded with a number like four hundred.

The chapter on sun-spots begins with ancient observations, and continues, through the discovery of Faraday of the rotatory effect of magnetism on light, to the supplementary great discovery of Zeeman; and so on to its quite recent application by Prof. Hale to ascertain the nature of the hydrogen vortices in the upper layers of the sun, which appear to be more or less closely associated with the deeper-seated sun-spots below. Every one now knows that the lower regions of a sun-spot were proved to be powerfully magnetised by Hale's discovery of the Zeeman effect in the light emitted by them. This discovery has now been extended into most interesting detail, by the splendid power of the 150-ft. tower telescope erected on the top of Mount Wilson, with a spectroscope 75 ft. long sunk in a well below it. This telescope forms an image of the sun 16½ in. in diameter. A small sun-spot can be focussed on the slit of the 75-ft. spectroscope, so as to fall on a Rowland grating at the bottom of the well; and, though the slit is only three thousandths of an inch wide, the light passing through it is returned as a long spectrum extending 40 ft. from red to violet—a spectrum of the second order, on photographs of which observations can be made, with complete polarimetric proof that the interior of a spot produces precisely similar effects to those of an ordinary powerful longitudinal magnetic field.

The result has been to confirm the importance of the eleven-year solar period, and to show that it is only half the real period, when not merely the appearance of spots but their magnetisation is taken into account. Sun-spots are known to begin far from the solar equator during a minimum, and gradually to form nearer the equator. It would be simple if we could say that all those in the northern hemisphere of the sun are magnetised one way, and all those in the southern hemisphere magnetised the other way, and that then in the next sun-spot period these directions were reversed. That is not true, though something like it is true It is not true because sun-spots do not occur singly. They occur for the most part in pairs, the two components of each pair not being necessarily equally well marked. They might be likened provisionally to the two opposite whirls we see when a teaspoon is drawn across a cup of tea; those two whirls are united by a semicircular vortex below. It may be so in the sun, though that is not yet clear. Allowing the analogy, however, the teaspoon must be drawn one way in the northern hemisphere and the opposite way in the southern during one eleven-year period; but in the next eleven-year period these directions must be reversed, giving twenty-two years for the time of the whole cycle of changes.

Moreover, by their magnetic properties, Hale found it possible to discover invisible or submerged sun-spots. They are all deep-seated disturbances, far below the photosphere; and it is only when a hydrogen whirl in the upper regions coincides with the electronic whirl below, that they burst out as it were and become visible. A great slowly alternating magnetic disturbance is going on in the body of the sun, of a quite unknown character, and with a twenty-two year period. These great electrical whirls must have a profound meaning, not yet dissected out. We are so dependent on the sun for everything, that they may have an unexpected influence on terrestrial phenomena and earth life. Meanwhile, we only know of them—at least until quite recently—by the manifestation we call sun-spots, when whirls happen to extend into the upper regions of the solar atmosphere and so break through.

Discovery is still going on; and it is to be hoped that Prof. Hale and his co-workers may long continue to elucidate this portentous phenomenon, which has proved itself so much more law-abiding than anything in our terrestrial weather and storms appear to be. There are some analogies: there may even be some connexion, but at present we can only say that whatever may be the truth about cyclones in the earth's atmosphere, they certainly exist on a huge scale in the solar atmosphere, or solar substance—for the whole sun may be obedient to the laws of gases at that high temperature—and that probably much more remains to be discovered about both.

OLIVER LODGE.

Modern Chemistry.

Chemistry in the Twentieth Century: an Account of the Achievement and the Present State of Knowledge in Chemical Science. Prepared under the guidance of a Committee representing the Scientific Societies, with Dr. E. F. Armstrong as Chairman and Editor. Pp. 281. (London: Ernest Benn, Ltd., 1924.) 15s. net.

IT was a very happy thought which prompted the preparation of this impressive work under the guidance of a committee representing the scientific societies, with Dr. E. F. Armstrong as chairman and editor. No one even remotely interested in the achievements of chemical science who visits the Chemical Hall at the British Empire Exhibition can fail to be profoundly impressed by the display of chemical products which he sees there, but he will not perhaps so easily realise the important part which British scientific workers have played in building up the knowledge which rendered that display possible. To make the achievements of British chemists clear to all the world is the purpose of the book under review; and the purpose is realised most excellently in this series of monographs written by distinguished men of science and preceded by an introduction from the pen of the editor. After reading through the 280 pages or so of which the volume consists, one has a feeling of pride in the work which British chemists and men of science have accomplished.

In a series of two dozen articles there is told, in a language which all who have a moderate acquaintance with chemistry can understand, the story of the growth of chemical science during the past quarter of a century, as promoted more especially by the labours of British chemists. In his general introduction, Dr. E. F. Armstrong gives an excellently composed survey of the domain as a whole, and we get here the kernel of the succeeding specialised articles. The opening sections of the work deal with the physical basis of matter: the atom, the molecule, the ion (by Prof. I. Masson); the structure of the atom (Dr. E. N. da C. Andrade); crystallography (Mr. T. V. Barker and Sir Henry Miers); and X-ray analysis of crystals (Sir William Bragg). These articles give a very complete survey of the whole domain of atomics, sub-atomics, and atomic arrangement in crystals, and will convey an adequate knowledge of these subjects to those whose main interests lie in other directions.

The story of the rare gases of the atmosphere is told delightfully by Dr. Travers, who does not fail to point out the practical applications of argon and helium and neon, a matter in which the layman is always specially interested.

The almost autobiographical sketch, "Milestones in Organic Chemistry," by Prof. H. E. Armstrong, one would gladly have seen expanded to greater length. It is a piece of history which all younger students of chemistry should read and ponder. The reviewer feels that it should have been placed before, not after, the article on the chemistry of the carbon compounds by Prof. J. F. Thorpe, in which the author discusses with amazing skill almost the whole realm of organic chemistry. Stereochemistry might perhaps have received rather more space.

The "Chemistry of Colloids" (Dr. W. Clayton), "Catalysis" (Dr. T. P. Hilditch), and "Fats and Oils" (Mr. J. Allan), are brief but clearly written, and will be read with pleasure. The story of one of the most notable British contributions to organic chemistry, the work of the St. Andrews school on carbohydrates, is told, as one would wish it told, by the director of the investigations, Principal Irvine. The work of Scottish chemists also finds a prominent place in the "syntheses in the terpene series," and one regrets that no room was found for an article on stereochemistry, to the development of which past and present workers in University College, Dundee, have very largely contributed.

"Cellulose" (Mr. C. F. Cross), "Colour in Nature" (Mr. R. Furness), "Coal-tar Colours" (Mr. E. A. Bearder), all deal with sections of chemistry which have been largely developed by British chemists, and the enormous growth of the cellulose industries, production of viscose silk, etc., is one of the achievements of applied chemistry of which British chemists may be proud.

How great has been the progress in biochemistry and in branches related thereto, is well seen from the interesting series of articles by Drs. F. L. Pyman and T. A. Henry ("The Alkaloids"), by Dr. R. H. A. Plimmer ("The Nitrogenous Constituents of the Living Cell"), by Dr. A. Harden ("Biochemistry and Fermentation"), and by Sir John Russell and Mr. H. J. Page ("The Chemistry of the Soil and of Crop Production").

The development of the production and utilisation of alloys and of pottery and refractories is described by Prof. C. H. Desch and by Mr. Joseph Burton. Dr. H. F. Coward contributes an interesting article on "Flame, Fuel, and Explosion," in the study of which Great Britain holds a foremost place; and Sir Robert Robertson writes, as few others could write, on "Explosives." The achievements of British chemists since 1914 in this important section of chemistry are perhaps insufficiently known and insufficiently appreciated. "The Chemistry of Photography," by Sir William Pope and Mr. W. Clark, fittingly concludes the volume. The production of plates sensitive to light of all colours and capable of giving a correct

rendering of different colour tones is a great advance due to chemists, and in the production of the necessary dyes the Cambridge chemistry school occupies a prominent position.

For this great record of achievement all British chemists, at least, will be very grateful. For some reasons, perhaps, one might have preferred a more homogeneous composition from a single pen; but in the time available such a production would have been impossible. On the other hand, compensation is found in the fact that impressiveness is added to the tale, and a sense of the magnitude of the contribution of British workers to chemical science is given by the rapid change of subject and of literary style. This book should itself occupy a prominent position in the Chemical Hall at Wembley. ALEX. FINDLAY.

The Unity of Life.

Life: a Book for Elementary Students. By Sir Arthur E. Shipley. Pp. xvi+204. (Cambridge: At the University Press, 1923.) 6*s*. net.

SIR ARTHUR SHIPLEY'S little book is of an unusual type. "A year ago," he says in his preface, "the University Press asked me to write a book that would make students of elementary Biology think." Perhaps this is putting the matter a little strongly: it is scarcely just to suggest that students of elementary biology have not previously used their brains.

In his book Sir Arthur has tried to get away from the type system, and "to emphasise the unity of Life and the interrelation of living organisms." But he has still another purpose. "Finally, I venture to hope that this book will be not without interest to the public that is not preparing for examinations, and thank heaven that public is still in the great majority!"

What we lack in Great Britain is not school text-books of biology. On the contrary, there are too many, and they are usually too large, too well-organised and too informative. The great desideratum is a school *reader* —a book that might really interest a reasonable proportion of boys. "Life," if not the ideal book for the purpose, is at least of the desired type.

As the author's friends would expect, it is not only lucidly but engagingly written. You may tell a schoolboy a dozen times the percentage of water in the human body, and ten to one he will forget it. But when he reads "Even the Archbishop of Canterbury comprises 59 per cent. of water," he may remember. Or again, we are all taught that plants differ from animals in obtaining their nutriment from inorganic compounds. But the fact becomes vivid and fraught with consequences when we find it put as Sir Arthur puts it: "Their food comes to them as the roast geese in Heine's description of Heaven perpetually flew up to the angels offering them tureens of delicious soup;" but "the pleasure of the chase is denied them. Their food must be intolerably monotonous and extremely insipid. . . . Yet one hears no complaint."

The description of what a patch of grouse-moor would look like if magnified a hundred times is alone almost worth the price of the book. Admirable too is the dictum, "Fleas do not jump anything like the height or length that you think they do when you are trying to catch them." As a finale, we cannot refrain from quoting from the characteristic section on appetite. "Hunger undoubtedly induces people to eat food which a well satisfied man would not care to tackle. On the other hand, elaborate sauces and good cooking will often tempt a jaded appetite to put forth new efforts." Then we are told of the gastronomic preferences of Sydney Smith, Disraeli, Charles Lamb, and Dr. Johnson, and are hoping for more, when our author's conscience pricks him and he ends, "But I must stop dealing with these literary appetites, and get on with the next chapter." But meanwhile in another chapter he has made an important pronouncement on the same subject: "Man is the only animal that cooks its food, but the distance between the rough cookery of the Australian native or an Abyssinian and that of a French chef is almost immeasurable. The higher branches of cookery are one of the chief arts in which men invariably rise superior to women. . . ."

The book is not, however, without its faults. There is too much illustrative detail; the beginner will often find it difficult to see the wood for the trees. Especially in the more recent fields of research, the author has not always shown himself very critical. There are various errors and omissions which should be rectified. *E.g.*, on p. 71, the only positive statement made about the economic status of wild birds is that "they do a great amount of destruction in our gardens and orchards, and our cornfields." This may be so, but if there is one established fact in economic ornithology it is that the net benefit due to birds is enormous. The statement (p. 5) that the ductless glands are "the cause of many obscure diseases" is surely a lapse of our author's usually lucid pen. Many free-living protozoa (including the familiar Paramecium) are easily visible to the naked eye, in spite of Sir Arthur's statement to the contrary (p. 18). If he had wished to be very up-to-date he might have put in a word of warning against overdoing the fat-soluble vitamin in adult life

However, Sir Arthur's book deserves a place in the library of every school department of biology; the professional biologist will read it with pleasure, and the layman with both pleasure and profit. But the author might make the second edition even better than the first.

Our Bookshelf.

The Principles of Insect Control. By R. A. Wardle and P. Buckle. (Publications of the University of Manchester: Biological Series, No. 3.) Pp. xvi + 295. (Manchester: University Press; London: Longmans, Green and Co., 1923.) 20*s.* net.

The literature dealing with the various methods of controlling injurious insects has now assumed such vast proportions that it is almost beyond the capacity of the economic entomologist to keep abreast of it. The necessity has arisen for periodic stocktaking of this accumulated information in order that the situation may be reviewed as a whole. Messrs. Wardle and Buckle have rendered a very distinct service in providing an excellent résumé of the present-day position with regard to insect control. In undertaking this task they have had the difficulty of sifting a literature often contained in unfamiliar languages, and scattered through a heterogeneous series of scientific, technical, and practical publications—many of which are relatively inaccessible. The collation and arrangement of the extracted information also presents certain difficulties, particularly on account of the wide and disjointed range of subjects dealt with.

These troubles have been surmounted by the authors very successfully, and they have managed to produce a very readable and coherent book. Their method has been to divide the volume into four parts, comprising altogether sixteen chapters. Part I. is devoted to biological means of control, including host-resistance, effects of climatic factors, disease, predaceous and parasitic insects, and insectivorous birds. All these different subjects are, for the most part, adequately treated. Part II. is concerned with insecticides, and is the longest and best section of the book. Part III. deals with mechanical control, including cultural methods, restriction of spread, storage of crops, and baits and traps. The section devoted to cultural methods might perhaps have been longer in view of their importance, and more examples of such methods enumerated. Part IV. is devoted to a short discussion of legislative control, and the book concludes with an appendix on various types of insecticide machinery, together with a very good classified bibliography. In a few words, it may be said that the volume should appeal to economic entomologists, since it covers the whole field of a subject which has not been previously surveyed in so comprehensive a manner.

(1) *Foundations, Abutments, and Footings.* Pp. xiv + 414. 20*s.* (2) *Structural Members and Connections.* Pp. xviii + 611. 30*s.* (3) *Stresses in Framed Structures.* Pp. xiv + 620. 25*s.* Compiled by a Staff of Specialists. Editors-in-chief, Prof. George A Hool and Prof. W. S. Kinne. (Structural Engineers' Handbook Library.) (London: McGraw-Hill Publishing Co., Ltd., 1923.)

The three volumes before us belong to a series of six, which is intended to provide a complete work of reference covering the design and construction of modern civil engineering structures A large number of prominent American engineers have co-operated in the production, and the commendable plan has been followed of making each volume, so far as possible, complete in itself. (1) The volume on foundations is copiously illustrated with examples taken from practice, and deals with all the matters which require consideration, from the preliminary investigation of the soil to the completed foundation, and includes such special points as underpinning, waterproofing, etc. Practically all types of engineering foundations are included. (2) The volume on structural members and connexions opens with brief statements of the general theory, occupying the first 171 pages; the remainder of the volume is taken up with the design of steel, cast-iron, wooden, and reinforced concrete members. The student who has mastered the elementary work on materials will find much of interest in the earlier part of this volume. The part dealing with design is exceptionally good, and contains much matter which is usually either omitted or receives scant treatment in British text-books. (3) The volume on framed structures also opens with a section on the general theory, occupying 158 pages. This part is by no means copied from the second volume, and includes methods of treating moving loads. The remainder of the volume deals with roof and bridge trusses, portal bracing, deflexion, secondary stresses, statically indeterminate frames, high buildings, towers, etc. The slope-deflexion method is generally employed for the solution of statically indeterminate frames in this treatise. Taking all three volumes, the authors have succeeded in producing an extremely valuable work of reference which cannot fail to be of service to civil engineers.

Theory and Practice of Mine Ventilation: a Text-book for Students and a Book of Reference for Managers and Under-managers. By Thomas Bryson. Pp. viii + 255. (London: E. Arnold and Co., 1924.) 8*s.* 6*d.* net.

Mr. Bryson is an experienced teacher of mining and is well known as a writer in mining technology. He has been at considerable pains to present his material in that order and manner which renders it most readily assimilable by the majority of his readers. The subject is undergoing re-solution; its treatment just now is difficult, and there is evidence that the author has not found it easy to balance between obsolescent dogma on one side and the quicksands of controversy on the other. The task is too Blondin-like to escape an occasional slip. We observe, for example, a repetition of the usual fallacy in reference to the origin of the "fuel cap," as the non-luminous mantle of a flame is inappropriately called. Nor do we agree with the neglect of the "dynamic water-gauge" at the expense of the "static gauge," especially as the former is required in determining the efficiency of fans. Again, the simpler and more precise form of Pitot tube made by the Cambridge and Paul Scientific Instrument Company is to be preferred to the type illustrated, and the simpler British alternative is more satisfactory than the hygrodeik.

It is to be doubted whether the inclusion of "ventilated" colliery plans without complete analysis can be of benefit. The author has, perhaps, attempted the impossible in treating of the "ventilation of plans" in a single short chapter.

Mr. Bryson is a strong and convincing advocate of

the direct method of expressing ventilating resistance—a method which he places to the credit of Cambessédès—and for his presentation of that side of the subject we have nothing but praise.

The reputation which Messrs. Arnold have gained as the producers of well-printed and capably edited scientific text-books is not likely to be diminished by this volume, the virtues of which considerably transcend the defects.

Bibliographie de la relativité : suivie d'un appendice sur les déterminants à plus de deux dimensions, le calcul des variations, les séries trigonométriques et l'azéotropisme. Par Maurice Lecat, avec la collaboration de Mme M. Lecat-Pierlot. Pp. xii+291+47. (Bruxelles: M. Lamertin, 1924.) 90 francs.

It is a striking instance of the acceleration of ideas in the modern world that a theory which five years ago was known only to a narrow circle of mathematicians engaged on an abstract and abstruse problem, and until then unverified, should have produced already a flood of literature. The mere catalogue of the books and articles written on the principle of relativity occupies 290 pages, and an appendix of more or less associated mathematical works, another 47. A whole century elapsed before the hypothesis of Copernicus became the universally accepted Copernican theory, and at least one generation passed before Newton's gravitation formula received general recognition. Of course in neither case was the proof so dramatic and the conviction so immediate and the interest so intense as in the eclipse expedition of 1919. The nearest analogy to that was Pascal's experiment with the barometer on the Puy de Dôme in 1648, which established the theory that the atmosphere has weight.

The author's incentive to compile this catalogue and the diligent application it required are set forth in a rather curious preface, in which the writer, a pacifist and cosmopolist, bemoans the militarism of his country and its government. The relevance is not quite clear. He tells us, however, the significant fact that numerous authors, almost all university professors, begged him with a touching insistence, that he would omit some of their writings, if not all, because they were completely false. To this request, however, he informs us he was inexorable. No doubt selection would be difficult and hazardous, but it seems hard that a writer should be held to the fatal ὃ γέγραφα, γέγραφα.

The Birds of Portugal. By William C. Tait. Pp. xii+260+10 plates. (London: H. F. and G. Witherby, 1924.) 18*s.* net.

When one thinks of the many ornithologists and bird-lovers in Great Britain, and of the numerous books on British birds, it is surprising to learn that Mr. W. C. Tait knows of only one native field ornithologist in Portugal, where he has himself for long been resident, and that the literature on Portuguese birds is exceedingly meagre. His own book on the subject fills a gap in a useful way. It is almost entirely devoted to a systematic account of the status in Portugal of each species, no attempt at descriptions of birds being made. An introductory chapter describes the physical characteristics of the country. A second general chapter deals with migration, giving a somewhat disjointed but nevertheless interesting account of its Portuguese aspects. Many species which are native to Northern Europe are only winter or passage visitors to Portugal, and that country is perhaps interesting to us, ornithologically, chiefly by reason of its place in the migratory path of our own summer birds. In an appendix, Mr. Tait gives a list of all the marked birds which he knows to have been recovered in Portugal, although we notice that this is not quite so complete as it could have been made from published sources; nearly thirty species are represented in the list, in which birds marked in the British Isles and in Holland bulk most largely (little marking is done in France), although there are also birds from Germany, Denmark, Sweden, Czecho-Slovakia, and Switzerland.

Developments in Power Station Design. By E. Austin. (The Engineer Series.) Pp. xv+271. (London: Constable and Co., Ltd., 1923.) 31*s.* 6*d.* net.

This book will be found useful and interesting by every one connected with the design of electrical power-houses or associated with the installation and operation of steam and electrical plant. The author looks forward to the time when every factory will be driven electrically and power production will be confined to very large power stations. Before this happens, however, it is essential that every manufacturer who generates power for his private use should cut down his consumption of fuel to a minimum. This is highly desirable, not only to reduce his working expenses but also to prevent waste of the nation's coal resources.

There are excellent chapters on pulverised coal-plant, low temperature carbonisation, and waste heat. The boiler-house plant is discussed very thoroughly, but we should have liked a more thorough discussion of the electrical side of power generation. It is a pity that up to the present time very little progress has been made with the huge scheme outlined by the Coal Conservation Sub-Committee in 1918. This is partly due to the lack of interest in the subject by the nation.

Cobalt Ores. By Edward Halse. (Imperial Institute: Monographs on Mineral Resources, with special reference to the British Empire.) Pp. ix+54. (London: John Murray, 1924.) 3*s.* 6*d.* net.

This small work forms one of the series of Imperial Institute Monographs and follows the familiar arrangements of its predecessors, commencing with a description of the occurrences of cobalt ores and the uses to which the metal is applied, this being followed by a chapter on the sources of supply of cobalt ores within the British Empire and in foreign countries. As usual, a useful bibliography completes the volume. The work has been quite satisfactorily done, though it must be admitted that the task in this case was a tolerably easy one, as a good deal of the matter was ready to hand. The Canadian Department of Mines has published a good deal of information about cobalt, particularly the researches on the metal and its alloys by Dr. H. T. Kalmus. Naturally the statistical and other material collected by the Imperial Mineral Resources Bureau has been made use of. The little work can be recommended to any one who desires a concise review of the occurrences and distribution of the ores of cobalt.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Use of "Shear" in Geometry.

WHEN an area or solid is subjected to "shear," although the boundaries are changed in form, the area or volume remains constant.

This characteristic of shear may be applied in the demonstration of a large class of geometrical propositions, and I have found it useful in many physical inquiries.

If any plane area is supposed to be divided into straight linear elements, parallel to a given axis, and if each element is caused to move in its own direction by an amount proportional to its distance from the axis, then if the axis passes through the centre of inertia of the area, the result is a pure shear. In any other case both shear and displacement are produced, or if the axis is infinitely distant, the

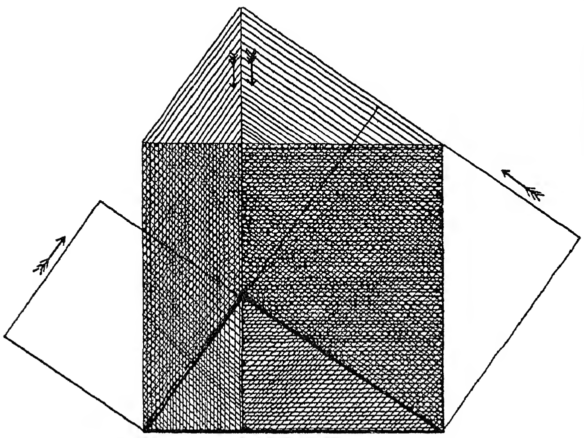


FIG. 1.

change becomes a simple displacement without distortion.

The constructions and proofs furnished by the method of shear seldom require the use of words or writing, but may be compared to the putting together of picture-puzzles in which the pieces, while retaining a constant area, may be changed in form and position according to certain rules.

The following examples will indicate the kind of propositions to which the shear method is applicable:

(1) If one side of a triangle is given, and a line parallel to that side is drawn through the vertex, then by a single shear, that is, by shifting the vertex along the line, every possible triangle can be formed which has the same base and area as the original triangle.

(2) If two sides of a triangle are given, the area of the triangle is a maximum when the angle contained by the given sides is a right angle.

(3) From this it follows that the maximum area of any polygon the sides of which are given occurs when the angles of the polygon lie on a circle;

(4) and, hence, the maximum area which can be enclosed by a line of given length is a circle.

(5) By two shears, any triangle can be converted into a rectangle of equal area.

(6) By two shears, any rectangle can be converted into an equal square.

(7) Such of Euclid's propositions as relate to equality of areas can be dealt with by shear. As an example the proof of Prop. 47, Bk. I is shown in Fig. 1. (Here the successive pairs of shears are indicated by single and double hatching.)

(8) A circle of radius r can be converted into an ellipse with semi-axes a and b ($r^2 = ab$) by a shear the magnitude of which is $(a-b)/r$ (see Fig. 2).

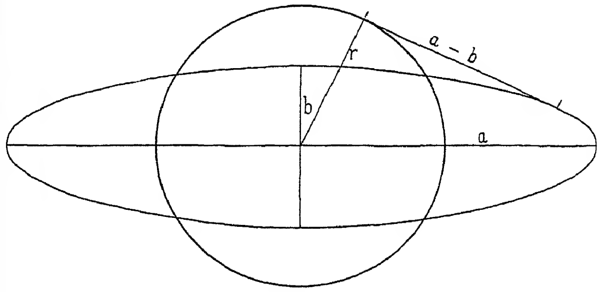


FIG. 2.

Often there are several ways of arriving at the same result, and in complex cases (especially in three dimensions) it requires some practice to select those shears which produce the required change of form with the fewest operations. It is always possible, however, by the shear method to transform any plane or solid figure into any other assigned form having the same area or volume.

A. MALLOCK.

9 Baring Crescent, Exeter,
June 6.

Mendelism and Evolution.

ALTHOUGH I do not wish to defend Dr. Annandale's theoretical views, or to maintain that his evidence for his conclusions was sufficient, I feel tempted to make some comments on Mr. J. S. Huxley's letter in the issue of NATURE for June 7. First, I should like to point out that Mr. Dover was using an unfortunate expression in writing that "some inherited characters at least are persistent." It is generally agreed that all inherited characters are more or less persistent. It would seem that Mr. Dover meant that some effects of environment are inherited.

Mr. Huxley states that no biologist disputes that "the differences seen between species, genera, etc. . . stand in some intimate relation with their environment." The proposition is disputed by myself for one, and by Mr. Bateson for another, and Mr. Huxley will admit that Mr. Bateson at least is a biologist. It is necessary for "progress in evolutionary biology" to distinguish between those characters which are obviously in relation to the environment, and those which, although diagnostic of species, genera, etc., exhibit no such relation. There is no evidence concerning the majority of specific characters that they are in intimate relation with the environment.

Mr. Huxley considers that experiment is the one thing necessary for the elucidation of evolutionary problems, but I have long ago come to the conclusion that experiment by itself is of no more value than observation by itself. Two other things are essential—(1) a real and thorough understanding of the phenomena to be explained and the problems they present, (2) sound reasoning applied both to observation and experiment.

Instances are almost daily afforded of unsound reasoning from experiments, leading to erroneous conclusions applied to problems which are imperfectly understood. For example, Prof. T. H. Morgan discovered that castration of hen-feathered cocks was

followed by the development of normal cock-feathering, and drew the conclusion that secondary sexual characters were, or might be, the by-products of internal secretions the real "utility" of which was quite different. J. T. CUNNINGHAM.

University of London Club,
21 Gower Street, W.C.1.

MR. HUXLEY seems to have missed (NATURE, June 7) the main point I wished to emphasise, namely, that while criticism of one investigator's views by another is always valuable, it is stretching the point to attempt to define the grounds on which an opinion may be advanced. It is natural for a man who has studied a group of phenomena from a certain viewpoint to formulate an opinion as the result of his studies. If the admitted limitations of a paper were appreciated, together with the difficulties under which some zoologists work, I imagine they would be free from the type of criticism under discussion. That Dr. Annandale's opinions may have been strengthened or modified by experimental data I do not deny, and if Mr. Huxley's letter directs attention to the neglect of experimental work in India it will have served a useful purpose; but, as I said, it is expecting too much to require a man already engaged in studies so diverse as Dr. Annandale's to supply the need himself.

Mr. Huxley's assumption of my lack of knowledge of his studies on the courtship of birds is perhaps natural. I may mention, however, that I have always followed his writings with interest, and I ask his indulgence if I missed the ecological importance of the paper he refers to, and previously regarded it as a valuable contribution to bird "behaviour," or rather psychology.

With reference to Mr. Huxley's concluding epigram I would point out that, apart from the limited scope of Dr. Annandale's paper, attempting as it did only correlation, it seems to be inconsistent with recent opinions on the notion of cause. Mr. Bertrand Russell ("Mysticism and Logic and other Essays," pp. 180-208: London, 1919) regards the word "cause" as "so inextricably bound up with misleading associations as to make its complete extrusion from the philosophical vocabulary desirable," and if I interpret him aright he proves that the idea of causation (absent in advanced sciences) as a fundamental axiom of science is erroneous, and that the supposed "causation" is really correlation. Accepting this argument, the geneticist is also correlating, though in a manner quite different from the methods of the pure ecologist. CEDRIC DOVER.

London, June 12.

Frequency Curves of Genera and Species.

IN NATURE for June 7, Mr. Tate Regan refers to "the series x, $x/2$, $x/3$, $x/4$, etc. . . . x/x, representing the number of genera with 1, 2, 3, 4, etc. species in a group where the sizes of genera are purely a matter of chance." I am unable to attach any *definite* meaning to the phrase "are purely a matter of chance," since the sizes might be "a matter of chance" in many different ways, and I do not see what process Mr. Tate Regan has supposed to be followed. Will he be so good as to state exactly in what way he supposes the systematist to operate, and to show how the series in question arises from his operations? G. UDNY YULE.

St. John's College, Cambridge,
June 10.

THE simple graph published in NATURE of June 7, p. 822, by Mr. Tate Regan demonstrates the result of log plotting $xy = n$, but is otherwise irrelevant. For if the matter were so simple as that, then an infinity of species per genus would be as probable as an infinite number of monotype genera, and there would be no room on the earth for us. The introductory chapter of Mr. Udny Yule's remarkable paper in the *Philosophical Transactions* is carefully written for the non-mathematical biologist, and should be read by all such. W. LAURENCE BALLS.

The Orchard House, Bollington Cross,
Near Macclesfield,
June 18.

Study of Explosions.

WHETHER anything physical and instructive about the atmosphere can be learnt from a study of purposely produced explosions, I am not sure. Ordinary explosives must waste much of their energy on the earth, and if atmospheric waves are wanted, it would seem better to explode a balloon filled with a detonating gas, say a mixture of hydrogen and oxygen, at a considerable height. Gas exploded without any rigid envelope, as in a soap-bubble, makes a tremendous noise, since the energy is wholly expended on the atmosphere. OLIVER LODGE.

Ball Lightning.

HAVING read the article on Ball Lightning by Dr. Simpson in NATURE of May 10, p. 677, I thought the following account of what I once witnessed, and believe to have been ball lightning, might prove of interest to some of your readers.

In August 1900 I was staying at the Voxli Hotel, Hankelid Fjeld, Telemarken, Norway. The hotel is 776 metres above sea-level and not far from the Hankelid Pass (1123 metres). On August 21 there was a terrific thunderstorm, towards the end of which I saw the particular lightning flash which I think must have been ball lightning. I will quote the actual words in which I attempted to describe the occurrence at the time

"We were sitting in the dining-room at supper (precisely 8 o'clock Norwegian time); on an ordinary day it would still have been good daylight, but owing to the storm it was only just light enough to see the outline of the hills on the opposite side of the lake. This was the direction (south-west) from which the storm was coming, and I had been watching the particularly vivid lightning for some time, when suddenly I saw a streak of 'yellow,' apparently about one inch broad, dart from the sky just above the top of the hill opposite and, gradually falling, make straight for where I was sitting. I was too spellbound to move, and the length of time of the whole occurrence was too short to call the attention of those who were sitting with me. I remember having the sensation that it must hit my forehead, when just as it got in front of the hotel window it changed to a ball of dazzling yellow fire (about the size of a cricket-ball) and then burst with a frightful crash, emitting volumes of violet-coloured flame, which spread in all directions. This must have happened in one or two seconds, but for several minutes afterwards I was completely dazed.

"Next day I examined the ground and found the track of the flash commenced just 20 metres (no yard measure to be had here) from the hotel window. The whole of the surrounding space is covered with small sods and branches of trees, and two or three small trees are uprooted. The most noticeable thing is a

furrow in the ground, in plan shaped like a horse shoe, but curved at both ends. Its entire length is 44 metres: its breadth varies from 7 to 24 centimetres and its depth 4 to 12 centimetres. In the path of the furrow is a large granite boulder from which two respectable-sized lumps have been cut off, one I could just lift, the other (thrown 5 metres from the boulder) I could just move but could not lift. The furrow then skirts round the edge of the boulder for a long distance, in places being completely underground. It becomes visible again farther on, passing under the roots of a small shrub, and shortly after meets the face of another rock 3 metres high The discharge must have passed up this face, for it has left a track on the top of the rock, where moss has been torn off; but just beyond the bare rock falls into the lake and nothing more is visible."

I have some "snap-shot" photographs of parts of the track of the furrow; they are not large enough to show much detail, but I shall be glad to forward them for inspection to any one interested.

ARTHUR W. CROSSLEY.

Shirley Institute,
Didsbury, Manchester.

The Spiders of the Madeira Islands.

WHEN in the Madeira Islands a few years ago I collected some spiders, which have now been kindly determined by Dr. N. Banks Although the collection is small and relatively unimportant, it suggests some problems of general interest. At and about Funchal, Madeira, I obtained *Cyrtophora citricola* Forsk., *Epeira crucifera* Lucas, *Mangora acalypha* Walck, *Teutana grossa* Koch, *Lepthyphantes tenuis* Blk, *Xysticus insulanus* Thor, *Clubiona decora* Blk., and *Chiracanthium albidulum* Blk. In the island of Porto Santo I collected *Lycosa maderiana* Walck (abundant under stones), *Pholcus phalangioides* Fuessl. (in an outhouse), *Argiope trifasciata* Forsk (this African species also abounds in Madeira), *Ariadne porto-sancti* Kulcz., *Dysdera crocata* Koch, *Dictyna* (*Ergatis*) *puella* Sim., *Epeira crucifera* Lucas, *Ero aphana* Walck, *Xysticus insulanus* Thor, *Thanatus vulgaris* Sim., *Teutana grossa* Koch, and *Zilla x-notata* Clerck.

The spiders of Madeira have been discussed by several authors, comparatively recent papers being those of Warburton (1892), Van Hasselt (1891), Bösenberg (1895), Schmitz (1895) and Kulcznski (1899). I have not seen Kulcznski's account of the Schmitz collection, though I saw the spiders themselves in the Seminario at Funchal. Warburton lists the 64 species then known from the Madeiras, 35 being supposedly endemic. As the islands are of the oceanic type, a careful study of the spider fauna should give interesting results. The means by which spiders might reach the islands are probably four: (1) Young spiders on gossamer threads floating through the air, (2) introduction by man, (3) on the plumage of birds, (4) on floating objects. The first two may be presumed to be far the most important. Such forms as the Argiope and Pholcus may be safely put down as introduced. *Epeira crucifera* seems to be a recent introduction; it is not mentioned (at least under that name) by Warburton. It would be interesting to determine whether the species likely to be carried on gossamer threads are prevalent in the islands, and whether some species frequently so carried are absent

The differences between the spider fauna of Madeira and that of Porto Santo have not been clearly made out, and it is not known whether there are any special forms on the islets off Porto Santo. According to J. Y. Johnson (1863) there are three species of the large snail-eating wolf-spiders, *Lycosa maderiana* confined to Porto Santo, *L. blackwallii* Johns. to Madeira, and *L. ingens* Blk. to the Desertas. The snails on which they prey, representing endemic genera, are presumably much older inhabitants of the islands. Possibly there are endemic genera of spiders surviving in remote places. The collecting done so far has been mainly in the vicinity of the towns, or in the towns, and it may be that it does not fairly represent the fauna of the Madeiras T. D A. COCKERELL.

University of Colorado, Boulder,
May 29.

The Scotoscope.

CAN any of your readers explain the principle of the scotoscope which Pepys defines in his diary (Aug. 13, 1664) as an instrument enabling objects to be viewed "in a dark room"? It seems scarcely credible that in the seventeenth century any such instrument could have existed, and bearing in mind the lack of science which Pepys evinced, one is tempted to wonder whether he had misunderstood the instrument-maker's "camera obscura," which would account for his speaking of a "dark room" instead of saying "in darkness" or "in the dark."

Only one other reference (without definition) to the scotoscope is given in the Oxford Dictionary, and the word is generally defined in the dictionaries, through reliance on Pepys, as being what it suggests—an instrument for revealing objects in the dark. If it was merely a synonym for the camera obscura, such a definition is misleading. CHARLES E. BENHAM.

Colchester, June 18.

Chimæras Dire.

DR. FINKLER's experiments on the transplantation of the heads of insects have attracted both scientific and popular attention to a degree which was marked on the one hand by an exhibit last year at a Royal Society soirée and, on the other, by mention in the pages of *Punch*. It is desirable, therefore, to direct attention to an emphatic repudiation of his claims which has just been published in the *Zeitschrift für wissenschaftliche Zoologie* (vol. cxxiii. pp. 157-208) by Hans Blunck and Walter Speyer.

It will be recalled that Finkler stated that the heads of adult insects could be successfully grafted on to bodies of the other sex, and even on to bodies of distinct species belonging to widely different genera. He inferred, rather than observed, the union of tissues following the operation and hastened on to describe its remarkable results, physiological and psychological. The head of an herbivorous water-beetle persuaded a carnivorous body to be content with, and seemingly to digest, a vegetable diet; a male head led a female body into unwonted perversities; and a Dytiscus strove to moderate the colouring of its wing-cases to suit the sober tastes of its new Hydrophilus brain. Experiment was added to experiment, and water-boatmen abnormally coloured by inverted illumination transferred the abnormal coloration with their heads to other individuals not so illuminated.

It was to be expected that a field of work offering such remarkable possibilities would speedily be occupied by other investigators. The living material is easy to obtain, the technique is simple ("an Roheit schwerlich zu ubertreffen," say Blunck and Speyer), and the results are got in a brief space of time; and yet no one, with the solitary exception of Dr. Kammerer, appears to have claimed success in repeating even the less startling of Dr. Finkler's experiments.

Now Dr. Blunck and Dr. Speyer (already known by a long series of anatomical and biological researches

on the very water-beetles that were among the chief of Finkler's *corpora vilia*) come forward with a detailed and documented confession of their failure, after persistent attempts, to confirm the simplest of Finkler's results They followed carefully his instructions as to procedure, and only after this failed did they try to refine upon his technique. The severed heads certainly adhered to the bodies on which they had been placed, cemented, in fact, by the coagulated blood which dried to a chitin-like hardness, but in no case did the insects survive longer than others in which, after decapitation, the wounds were stanched with a little melted wax, in no case did the chimæras behave differently from the headless trunks; in no case did stimulation of the head produce reflex movement in the body or its limbs Microscope sections showed no attempt at regeneration or union of the tissues, but instead, a progressive necrosis, leading more or less quickly to the death, first of the head and later of the trunk. These results followed, even in cases of replantation where the severed head was replaced at once on the body from which it had been detached.

Dr. Finkler may of course be able to point out to us where the German experimenters have gone wrong, but there seems to be a familiar ring in their complaint that he has ignored requests to produce his chimæras, alive or dead, for investigation by others. He cannot ignore the challenge of their final words: "Die Wissenschaft hat angesichts der allen Erfahrungen widersprechenden Angaben des Wiener Autors keine Veranlassung, sich weiter mit ihm und seine Schriften zu beschäftigen." W. T. CALMAN.

British Museum (Natural History),
South Kensington, S.W.7

The Origin of Ores.

REFERRING to the very kind review by Prof. H. Louis of my book "The Geology of the Metalliferous Deposits" in NATURE of June 7, p 812, I wish to direct attention to one point. Prof. Louis quotes the following sentence: "It would perhaps be too much to say in the present state of our knowledge that all primary ore-deposits are of igneous origin, but this is a view which may very likely be established as a result of future work." He then goes on to instance the hæmatite deposits of Cumberland as ores which are certainly not of igneous origin. With this, of course, I entirely agree, and I wish to say that my statement was certainly never meant to include them, as may be seen by referring to p. 330 of my book. The emphasis in the sentence quoted is on the word *primary*, whereas I regard the hæmatites of Cumberland and northern Spain as secondary ores. Should a second edition of the book be called for, steps will be taken to make this point quite clear.

R. H. RASTALL.

Christ's College, Cambridge.

Exhibit of Pure Science at the British Empire Exhibition.

IN NATURE of June 21, p. 896, there is a reference to the instruments exhibited under my name in the Royal Society's section in the Government Pavilion at the British Empire Exhibition dealing with the measurement of atmospheric pollution. I should like to make it clear that the credit for the original idea underlying the contrast photometer exhibited is due to Mr L. F. Richardson. It is a development of the method described by him in the Proceedings of the Royal Society, A, vol. 96, 1919. The principle was further elaborated by the Photometric Sub-Committee of the Advisory Committee on Atmospheric Pollution, my share being only that of getting out a workable design and making the experimental instrument. I was fortunate in getting at the first attempt an instrument with remarkable sensitiveness and accuracy, which required practically no alteration and enabled a measure of light obstruction by fog to be obtained.

During the smoke fog in the afternoon of November 26 last in South Kensington, a fairly dense fog containing about $2\frac{1}{4}$ milligrammes of soot per cubic metre and about 24,000 smoke particles per cubic centimetre, the obstruction of light in 50 feet was 46 per cent. In the morning of the same day at 11.45 the amount of suspended matter was 3·8 milligrammes per cubic metre and the number of particles 82,000, the obstruction of light in 50 feet being 75 per cent.

J. S. OWENS.

Advisory Committee on Atmospheric Pollution,
47 Victoria Street, Westminster,
London, S.W.1, June 25.

Birds as a Geological Agent.

ALL along the tops of the cliffs of the Undercliff from Ventnor to Blackgang empty shells of the common limpet are found in large numbers, and it has usually been assumed that their shape has caused them to be blown by the wind from the beach over the cliffs. There are so many of them that I have found it difficult to believe this theory, and on mentioning it to a local naturalist, he has assured me that he has seen rooks and jackdaws pick them up from off the rocks while living, and convey them in their beaks to the trees where they roost and nest and to other places, and after feeding on them, cast away the empty shells. This may account for the mixture of marine shells with land shells in some of the tertiary strata which is sometimes inexplicable.

EDWARD A. MARTIN.

285 Holmesdale Road,
South Norwood, S.E.

A Substitute for the McLeod Gauge.

THE letter on the McLeod gauge appearing in NATURE of November 3 has only just come to my notice.

There may be gauges which, having been compared with a McLeod gauge, will give equivalent readings, but there is no substitute for the McLeod gauge in its perfect measurement of low pressures, expressed in height of mercury column.

If the McLeod gauge is used with proper knowledge, it *will* indicate aqueous vapour as well as permanent gases. When the gauge is so proportioned that the difference of the height of the mercury in the capillary columns is less than 4 mm. and the temperature is above 0° C., any aqueous moisture present will act as a permanent gas and will give a true reading of the pressure absolute.

HENRY A. FLEUSS.

47 Albert Road, Caversham, Reading,
June 16.

Ceremonial Banquets.

I HAVE recently received an invitation to forward a cheque for two guineas, as a fee for attending the banquet in connexion with the Kelvin Centenary. It is difficult to understand why the memory of a man of simple habits should call for such a sumptuous repast, or why scientific workers of frugal habits should be excluded from such a celebration. In view of the growing tendency to limit functions such as these to men of means rather than to men of science, it is surely time to make a protest against the methods of organisation which lead to so undesirable a result.

F.R.S.

The Plant Commonwealth and its Mode of Government.[1]

By Sir Frederick Keeble, C.B.E., F.R.S.

The plant commonwealth lies within the contours of an individual plant—rose, lily, grass, oak tree or any other. The physical features of the commonwealth have been surveyed and are well known. Notwithstanding their differences in outward aspect, all the members of the commonwealth—root, stem, leaves, and flowers—own a common plan of organisation. As the human being is the unit of a commonwealth of nations, so is the cell or protoplast the unit of the plant commonwealth. Just as certain men have the appearance of simplicity, so has the plant cell—a minute mass of nucleated cytoplasm, bounded by a solid wall of cell-wall substance, of such small dimensions that one thousand cells might lie comfortably side by side along the diameter of a penny piece. Yet, as is the case with man, the simplicity of the cell is illusory. The cell lives, feeds, respires, grows, and does many different kinds of work. Nor does it live unto itself alone. In all its manifold activities the cell influences and is influenced by other of the well-nigh innumerable cell units of the commonwealth. Indeed, the messages which by word of mouth, by post and telephone, telegraph and wireless, pass between members of our own commonwealth and leave us but little peace, are rare by comparison with those sent and received by the living cells of plants. Throughout life they are always "listening in." In the simplest plants of all—the unicellular plants—the cell is the commonwealth. So is it in the highest (multicellular) plant at the moment of the rebirth of the individual within the ovary of the flower of the mother-plant. All plants begin life each as a single, minute mass of semi-fluid nucleated protoplasm. Every activity evinced by this living particle shows alike the diversity of its unrecognisable parts and the integrity, that is, the individuality of the whole, and throughout life diversity of activity and oneness or individuality alike persist.

From simple raw materials the cell-protoplasm restores and augments itself, and gradually stage by stage the plant carves out its body from this increasing mass of living substance. The primal cell grows and divides to form two daughter cells, each, like the mother cell, consisting of nucleated protoplasm invested by a wall or coat of cell-wall substance. Yet though a solid wall divides them, the daughter cells are not isolated from, but remain in communication with one another. For, in the first place, the separating wall is very thin and soluble substances may pass across it readily, and, in the second place, fine strands of cytoplasm radiating from the central mass penetrate into pits in the cell wall and, joining or all but joining with corresponding strands from a neighbouring protoplast, maintain vital touch between the cells. So in like manner the daughter cells divide, and the cells to which they give rise maintain vital contact by their protoplasmic connecting fibres, until after many divisions the embryo is recognisable within the swelling seed. If by some magical liquor the cell walls and all the non-living contents could be dissolved away and the transparent semi-fluid protoplasm made hard and visible, the contours of the plant would still be recognisable.

[1] Discourse delivered at the Royal Institution on Friday, March 21.

Not all of the cells which compose the body of the embryo plant remain unchanged. Some, it is true, appear to do nothing else but grow and divide. They are the producer or embryonic cells destined throughout the life of the plant to carry on the work of cell formation. Groups of them are to be found at all ages of the plant in the growing point of the root and in the buds on the stem. In long-lived plants, after a thousand years and many thousands of divisions, these embryonic cells still retain their powers of cell-formation. Theirs is the gift of perennial youth; they never grow up. Once established, a growing point exercises a dominating influence over the broods of cells which it throws off by the division of its component embryonic cells. In some way, as yet unknown, it influences or perhaps determines the morphological fate of its offspring. For, as has been shown recently, a minute fragment of a root tip $\frac{1}{25}$ in. in thickness, if cut off and fed with mineral salts and suitable proteins, grows, divides, and in the cells which it produces, the same differentiation appears as in the normal root.

Other cells of the plant body soon cease to divide, but undergo no very great change of form. They become the general working cells of the body. Others assume curious and characteristic forms and, grouped together, constitute gangs of cells—skilled cellular artisans—to each of which some special task is assigned. Yet other cells or groups of cells undergo greater change of size and shape. For example: those destined to give rise to the woody vessels along which sap passes from root to stem grow wide and very long, join above and below in single file with cells like themselves, build thick and woody longitudinal walls, often beautifully sculptured, and, losing their contents and dissolving away their cross walls, form long uninterrupted tubes—mere aqueducts. It requires but little imagination to realise how imperative must be the constraint brought to bear on those wood-forming cells to induce them thus to immolate themselves for the benefit of the plant commonwealth. Their fate suggests that as the commonwealth develops the cellular units suffer more and more curtailment of liberty. Each is constrained to endure a limitation of freedom, and each imposes a limitation on that of other units of the plant body. In this compromise between liberty and social obligation a new and higher unit is fashioned—the individual plant, that is, the plant commonwealth. If this way of regarding the individual be correct, it must be of interest to explore the nature of the messages which, passing between members of the plant body, bind them together and determine the subordination of the cells and their integration into an individual. On these trifles, "light as air but strong as iron," the existence of the commonwealth is based. It is to the origin, nature, and effects of these messages that I propose now to refer.

I know of no better way of approach to this task than by describing—at the risk of the smile it may evoke—the strange things that happen when a potato is peeled. An immediate effect of the operation is the setting up of a state of fever. During this wound fever the temperature of the tissues near the cut rises

rapidly as a result of increased cell respiration. The wounded cells die; those of the layer next to them, no longer hemmed in on all sides, find some relief from the bondage which held their activities in subjection. They grow out to form bladder-like or tubular projections. In the welter and confusion due to loss of touch with other cells, these cells break rank and become a law unto themselves. Their growth is, however, limited and aimless, and presently withering and turning brown, their dead remains form a thin dry skin over the wound. Behind the broken ranks the orderliness of behaviour of the cell layers is maintained; but it is a new order which these cells obey. They form a new front. Dividing rapidly and in a regular manner, these cells come to present the appearance of rows of microscopic bricks. When the originally single layer of dividing cells has given rise to several layers, the cells of the outermost form thick corky walls, lose their living contents, and come to consist of mere empty shells fitting as hollow bricks might fit closely one with another. Thus by the formation of wound tissue is the wound healed. Until recently, nothing was known of the provenance of the new orders which stir the cork-forming cells to activity and, releasing them from obedience to previous orders, cause these cells to renew their youth and reassume the power of division. But it is now known as a result of investigations made by Prof. Haberlandt that the renewed activity is called forth by messages from the stricken and dying cells.

The origin and nature of these messages may be determined by very simple experiments. For example: if the bulbous stem of a kohl rabi (turnip-stemmed cabbage) be cut across, all the changes just described may be observed to take place. But if the cut surface be rapidly and thoroughly washed with a stream of water, little or no cork formation occurs; the wound does not heal. When, however, the washed surface is covered with a layer of brayed-up cells of kohl rabi tissue, cork formation proceeds even more vigorously than it does in the unwashed wound. Whence it is to be concluded that messages are sent by the wounded cells and that the messages are of a chemical nature. As they die, these cells liberate some substance which, diffusing into the living cells, quickens them to activity and provokes their division. This stimulator of specific change may be spoken of as a wound hormone. Its presence may be demonstrated experimentally in many different kinds of wounded tissue, and in none better than in the succulent leaves of sempervivum and sedum. Leaves of these plants may be readily torn asunder without mechanical destruction of their cells; for the cell walls between the cells give and split so that the protoplasm of the cells remains intact. Now it may be shown that whereas by cutting a leaf and thereby destroying numerous cells the cell division provoking hormone is produced, by tearing it the hormone is not produced. The wound hormone, this message of healing, is sent out by the dying cells. Thus may plants rise by stepping-stones of their dead cells to higher things.

Further insight into the circumstances in which wound hormones are produced may be obtained by observing the effects which follow upon mechanical injury of delicate plant-tissues, as, for example, the multicellular hairs so often found on leaves and stems. These structures are formed each by the outgrowth and division of a single surface cell. This cell divides to form a row of cells placed end to end; after a few divisions growth ceases, and the constituent cells of the hair divide no more. If, however, the hairs on the leaf or stem of a coleus or zonal pelargonium be maltreated by cutting or pinching or by less drastic means, as, for example, rubbing gently between the fingers or brushing with a hair brush, cell division may in certain circumstances be resumed. If a hair be cut across with a sharp instrument the cell cut into dies at once, its contents dry up, and no division occurs in the remaining intact cells. But if the instrument, in removing the top of the hair, also bruises the cell beneath the one cut into, the bruised cell enclosed in its wall, though it dies ultimately, has time to prepare its message, and its last will and testament consists in wound hormone which, passing to the next-of-kin, endows that cell with renewed powers of cell division. The wound hormone, diffusing into a cell, exercises an attraction on the nucleus which moves up in the direction of the injury, and in consequence nuclear divisions and subsequent division occur in the part of the cell near the wall across which the hormone diffuses. In some plants, as, for example, the zonal pelargonium, the basal cell of the hair appears to resist injury more than the other cells, and hence it may happen that when the stem bearing the hairs is brushed not too harshly, all the cells of a hair are killed except the basal cell. If this sole surviving cell, though damaged as may be seen by a puckering of its wall, has not been mortally injured, it produces wound hormone and thereby stimulates itself to cell division.

It may, and I think it will be that these discoveries are destined to throw light on many obscure phenomena in plants. Thus it has long been known that by wounding a plant a turmoil may be set up which spreads from the seat of injury to the uttermost parts of the plant. When a branch of a tree is lopped there are repercussions in the roots buried deep underground. The turmoil is visible under the microscope. In normal circumstances the protoplasm of a plant cell presents no sign of movement; but in certain circumstances an incessant restlessness very marvellous to witness overcomes it. All its granular mass except the layer next the cell wall begins and continues long to circulate around the cell or else to stream up and down along certain lines. When tissues are injured this streaming or circulation of protoplasm begins in cells near the wound, infects the cells next to them, and so on until, like bees disturbed in a hive, the myriad protoplasts of the plant are all in active movement.

In the light of the experiments with wound hormones, it would seem probable that the propagation of the disturbance which leads to streaming is due to some chemical message passing by diffusion from cell to cell. Again, it would seem possible to ascribe the remarkable behaviour of the fertilised egg cell to the influence of a wound hormone. As is well known, the egg cell of a plant or animal remains quiescent until it is penetrated by the male reproductive cell. Soon after this event the fertilised cell begins actively to divide, and continues growth and division until the embryo has been formed. Ingenious experimenters

have shown that egg cells of the lower animals and of some plants may be caused to undergo division and to produce embryos even in the absence of fertilisation. Thus the unfertilised egg of a frog pricked by a needle has been caused to undergo division and development, and to give rise to fatherless tadpoles. Hence there would seem to be little doubt that, in normal fertilisation, the abrupt entrance into the egg cell of the male reproductive cell leads to the production of a wound hormone which acts specifically in provoking cell division.

It might be objected that such an hypothesis presupposes an almost incredible delicacy of protoplasmic organisation, but the objection has no weight with the plant physiologist who knows from long experience that disturbances of protoplasm, often so slight as to escape our own powers of perception, may suffice to produce marked and far-reaching effects in plants. The exposure of one side of the tip of the seedling leaf of oat or other grass to direct sunlight for periods of so brief a time as $\frac{1}{2000}$th of a second suffices to interrupt the uniformity of its upright growth and make it do obeisance to the sun. The tendril of the passion flower has a receptiveness so acute that the hanging upon it of a thread weighing no more than $\frac{1}{1000}$th of a milligram suffices to deflect the tendril from its course of growth. It curves in the direction of an incubus, the weight of which would have to be increased tenfold before we, if it were placed upon the skin, could be made aware of it by our sense of touch. The human eye is apt to distinguish small differences of light intensity. When we are young, our eyes can perceive the difference between a ninety-nine and a hundred candle-power lamp. As we grow old, acuteness of perception fails, and we are lucky if we can tell the difference between lights of one hundred and ninety-six candle-powers. A leaf can "tell the difference" between one hundred and 98·7 candle-power, so that its sensitiveness, as expressed by responsive movement, is equal to that of a fairly young eye. The trained eye is a wonderful instrument for perceiving whether or no a line be truly vertical, but I doubt whether its power is greater than that of the root of any plant. More than once a delicate experiment in plant behaviour has come to grief because the experimenter failed to notice that his table was not absolutely horizontal, and in consequence his plants not vertical. The plants themselves took heed of the displacement and set to work to rectify it to the undoing of the experiment.

(*To be continued.*)

Large Crystals of Iron.

THE paper by Prof. Edwards and Mr. Pfeil presented at the May meeting of the Iron and Steel Institute on "The Production of Large Crystals by Annealing Strained Iron" has now brought iron into the rapidly growing list of metals which can be obtained in the form of very large crystals. The research follows on a preliminary paper presented to the Institute by the same authors a year ago, in which they dealt with the commercial importance of coarse crystallisation in a number of defective stampings which had come into their possession. Methods of producing large metallic crystals may be classified under the following heads: (1) By slow cooling of the melt; (2) by drawing a rod slowly out of the melt; (3) by straining to a critical amount a test-piece composed of small metallic crystals, followed by heat treatment; (4) by the simultaneous application of strain and heat treatment to a metal wire. The method adopted by the authors is No. 3, which was introduced in 1921 by Carpenter and Elam in the case of the metal aluminium, and the large crystals produced are very similar in form.

It could have been predicted that iron would be more difficult to prepare by this method in the form of "single crystal" test-pieces than aluminium, for two reasons: (1) That no suitable form of commercial iron exists; and (2) that no heat treatment can be carried out above 900° C. on account of the A_3 change point at which the α to γ change occurs. Another difficulty presented itself in the course of the research to which reference will be made. The authors employed as their starting material mild steel plate 0·125 in. thick, containing 0·10 to 0·13 per cent. of carbon and the usual amounts of commercial impurities. The sheets were covered with a thin layer of scale which had to be removed by pickling in dilute sulphuric acid, leaving a dull metallic surface free from serious defects. The test-pieces used were from 8 to 12 in. in length by 1 to 2 in. in width. Chappell's earlier work having shown that the presence of carbon in iron restricts the size of the crystals which could be developed, and the authors' investigations of the defective stampings having shown that coarse crystallisation was more pronounced where decarburisation has occurred, it was decided to remove all carbon from the test-pieces before attempting to produce large crystals. It was necessary to determine carefully the conditions of decarburisation, since the problem resolved itself into obtaining an iron of suitable crystal size free from carbon. As the result of a large number of experiments, it was found that a grain size of approximately 120 grains per square millimetre is required. This was obtained by decarburising at a temperature of 950° C. for 48 hours (*i.e.* in the γ range), followed by slow annealing (12 hours from 950° to 100° C.). The complete removal of carbon was found to be necessary. From this material large crystal test-pieces could be prepared by an elongation of 3·25 per cent. produced by tensile stress, followed by annealing just below the A_3 change point (about 880° C.) for three days. The maximum size obtained was 4 in. × $1\frac{1}{4}$ in. × $\frac{1}{8}$ in.

A complication from which aluminium is free is the presence of a surface film of very fine crystals which masks the very large crystals produced, and in order to reveal them it is necessary to remove this layer. The authors' experiments show that in general this film was just one crystal thick, and they concluded that those crystals in the original material which had a "free boundary" did not undergo the same kind of change during deformation by tensile strain as the interior crystals. They found, however, that if the elongation was produced by rolling, the surface film of fine crystals was not produced after annealing.

Tensile tests were carried out on test-pieces cut from strips containing large crystals, so that the parallel portion in each case was occupied by a single crystal. Values of from 9 to 10 tons per square inch ultimate stress and 30-50 per cent. elongation on 2 inches were obtained, and may be compared with about 19 tons per square inch and 53 per cent. elongation obtained for the same material in the fine-grained condition. A single crystal cut from the coarsely crystalline strip can be rolled out to 100 times its original length and reduced from 0·125 to 0·001 in. without annealing and without showing any signs of cracking at the edges. The properties in this respect were very similar to those of the aluminium crystals made and tested by Carpenter and Elam. It was found, however, that in certain circumstances these large iron crystals were exceedingly brittle, a property not hitherto observed with aluminium. If a crystal were placed in a vice in a certain way and given a sharp blow with a hammer, fracture frequently occurred along what appeared to be a cleavage plane. A large number of crystals were broken in this way. Only in a few cases did bending occur, such as would happen in finely crystalline iron. In the large majority of crystals tested it was found possible to obtain fractures in two planes exactly at right angles. The authors consider it probable that the large crystals grown in strained iron possess a similar orientation.

Messrs. Edwards and Pfeil have established two important facts which bear on the production of large iron crystals: (1) The critical strain required to produce very large crystal-growth on subsequent annealing varies with the initial grain size of the material used, the larger the grain size the greater being the strain required. With very large crystals, sufficient strain to cause growth cannot be applied, since recrystallisation occurs at the crystal boundaries. (2) Surface crystals of the original finely crystalline aggregate behave differently from those in the interior and require a greater tensile strain before they will disappear.

The authors explain these facts in the following way. In the case of a single crystal it is considered that deformation occurs by a process of slip causing little change in the crystal lattice. Some change must occur, for single crystals of tungsten, aluminium, and iron are hardened by cold work, but in the case of single iron crystals, whatever change up to 25 per cent. elongation occurs is removed on annealing without producing recrystallisation. If, however, two crystals in contact are deformed, there will be interference with slip, owing to the change in the direction of the slip planes in passing from one crystal to the other. In these circumstances some other kind of movement must occur during deformation. X-ray analysis does not indicate any difference between the lattice constants of cold worked and annealed metals, but shows a relation in the former between the direction of the crystallographic axes and that of straining.

The second type of deformation is interpreted therefore as a rotation of the crystallographic axes accompanied by elastic strain. The depth to which this change penetrates from the boundaries depends upon the degree of deformation. With small crystals but little deformation will cause the depth to correspond with the radius of the crystals. The larger the crystals the greater the deformation necessary to cause the change to reach the centres. When this second type of deformation has penetrated to the centres (and the strain at the crystal boundaries has not exceeded a certain value) the authors consider that the degree of axial alignment due to rotation has proceeded to such an extent that, on annealing, it is easier for the atoms to form a single crystal than to revert to their original orientations. With very large crystals, however, before the second type of deformation has penetrated to the centres, the strain set up at and near the crystal boundaries has become so great that, on annealing, the atoms in these highly strained regions preferably form new crystals, *i.e.* recrystallise.

With regard to the small surface crystals, the authors consider that a greater degree of deformation produced by tensile stress is required before the change is sufficiently complete to permit of growth or absorption during annealing. When, however, the critical degree of strain is caused by rolling and the freedom of the surface crystals is thus at least partly removed, their growth or absorption can occur.

H. C. H. C.

Immigrant Cultures in Egypt.

By Sir FLINDERS PETRIE, F.R.S.

A GENERATION ago our view of Egypt was limited to three brilliant periods, without beginnings or connexions. The discovery of the predynastic ages in 1895 showed two successive civilisations, waxing and waning, which were disentangled by the classification of sequence-dating, and appear to have come in first from the west and then from the east. The further discovery of the royal tombs of the earliest dynasties at Abydos provided a monumental basis for what had, so far, only been recorded history. There the position has rested for twenty years, but recently much more has come to light, consolidating the long view of the past.

On a jasper cylinder seal of Asiatic work, the figure of a king named Khandy was identified with the same name recorded in the VIIIth dynasty of Egypt. As that king is shown receiving homage from a Syrian, and secondarily from an Egyptian, it appears that he was ruling in Syria and holding Egypt. Other foreign names in that dynasty indicate that the VIIth and VIIIth dynasties, who succeeded the first pyramid age, were Syrian rulers. This accords with the frequent use then of button badges, always of foreign work, and bearing designs known in Babylonia and Cilicia. Excavation of the cemetery of the IXth and Xth dynasties capital, Herakleopolis, showed an entire absence of the Syrian buttons, and a throw-back on to Egyptian lines, apparently due to a Libyan immigration.

Last winter the study of the rock tombs of the Uah-ka princes of Qau—south of Assyut—of the IXth and Xth dynasties, has opened a fresh view. It had already been noted that certain black granite sphinxes from Upper Egypt, which resembled the kings of the XIIth dynasty, were markedly of the Galla type. At

Qau, the temple-tombs cut in the rock are of exactly the plan of the Nubian temples, a form unknown elsewhere; and, further, the family name—Senusert—of the XIIth dynasty appears. These facts link together and agree with the Egyptian "prophecy" of the XIIth dynasty, that a king Ameny (=Amenemhat) should arise from the south, the son of a Nubian woman. It appears, then, that when the Syrians broke in on the north, the Gallas pushed down from the south, controlled the artists in black granite, and founded a rule of the south which centred at Qau; this was in alliance with the Herakleopolite dynasties, and eventually founded the XIIth dynasty at Thebes.

Last year there came to light some work of a prehistoric culture, differing in all respects from the recognised prehistoric Egyptian. This year the clearance of a stratified deposit showed that this unknown culture was as old, or older, than the early prehistoric age already recognised. As the known prehistoric culture is quite continuous on all sites, and bears nothing like the new material, the presumption is that we are handling remains of a still earlier period. This new culture is identical in the types of flint chipping with the flints so widely spread from the Fayum up to the Palestine desert. We have now certainly the general products of this people, who have as yet only been known by their flint work. Further, this work is closely like that of the lowest stages of Susa, and the Solutrean of Europe. All of these seem to be due to various waves of one Asiatic culture, and thus accord with the recent views in the "Cambridge Ancient History." The peculiarities of this earliest known culture in Egypt are: in flint, the swallow-tail arrowhead, delicate *vesica* tools pointed at both ends; in pottery, the thinnest and hardest ware known, polished black, with the surface streaked by comb-dressing all over; in beads, glazed steatite, garnet, and carnelian; in painting, the use of long rectangular palettes, concave at the ends, with green malachite, and red hæmatite face-paint. All of these may be seen in the exhibition of the British School in Egypt at University College, Gower Street, open on July 5-26. There will also be shown more remains of the earliest human period known in Egypt, from the gravels of the eastern desert; after further study, it is hoped to give some account of these.

Obituary.

CHARLES OBERTHUR.

BY the death, at the age of seventy-eight, at Rennes of the veteran naturalist, Charles Oberthür, workers in the study of insect life have suffered the loss of one whom personal tastes, the circumstances of life, and a persevering and enthusiastic character combined to make a conspicuous and leading figure among the fraternity of entomologists. As the printer and producer of his own works, Oberthür was able to give full scope to his conception of the requirements of entomological description and illustration. Similar ideals have presented themselves to others, but to few indeed has the opportunity been given to carry them out on so extensive and magnificent a scale. The splendid series of "Études d'Entomologie" and of "Lépidoptérologie Comparée" which emanated from his press at Rennes bear witness to his indefatigable labours in the advancement of his favourite pursuit, and to the liberal, one might even say the lavish, expenditure which he devoted to the worthy presentation of the results of his entomological studies. The beauty and accuracy of the hand-painted illustrations in these volumes have never been surpassed.

Though the order of Lepidoptera engaged most of his attention, Oberthur did much to further the subject of economic entomology, which he rightly recognised as being of high importance to an agricultural community such as that of the greater part of France. The material accumulated by him is of the greatest service to students of bionomics; but to Oberthür himself the various topics offered by evolutionary problems, such as those of protective resemblance, mimicry, phylogeny and distribution, made little or no appeal; nor did he concern himself with experimental investigation of the phenomena of heredity. But in his own line, and in the working out of his own methods, he was exceptionally efficient. Many have had occasion to be grateful for his kindly and helpful generosity.

PROF. FILIP POČTA.

WITHIN the past few months death has taken heavy toll among the professors of the Charles' (Bohemian) University of Prague. On January 7 died Prof. Počta, professor of palæontology and geology. He was born in Prague in 1859 and studied first in our University, then in Bonn, in the Musée d'Histoire naturelle in Paris, in the Lavalle Museum in France, and from there in Stockholm with Prof. Lindstrom. His first big work was a modern investigation of the sponges from the Bohemian calcareous formation, of which he studied not only the external form but also the interior skeleton, and this study he extended to sponges from Hungary, Dresden, France, and from the collection of the Bonn University. After this he studied the rudists and worked in the Sorbonne, the École de Mines in Paris, as well as in the British Museum. After the death of Prof. Novák he investigated the material which was left by Barrande, who intended to describe it in the eighth volume of his classical work, "Système silurien du centre de la Bohême." For this purpose Počta made a great collection of illustrations of corals and Cœlenterata, a collection which was, as regards execution, without a rival. He also deciphered for the first time the inner structure of the end chamber of Orthoceras. The first part of the eighth volume was published in 1894 and the second in 1902. Being originally a palæontologist, he became later on a geologist. He published much in both sciences in Bohemian, German, French, and Magyár. Počta was a member of the Royal Society of Bohemia, of the Bohemian Academy of Sciences, of the Geological Societies of Paris, Berlin, and of other learned societies. BOHUSLAV BRAUNER.

WE regret to announce the following deaths:

Dr. George Little, state geologist of Mississippi, 1868–72, and of Georgia, 1874–81, on May 15, aged eighty-six.

Prof. Charles Hunter Stewart, professor of public health, University of Edinburgh, on June 30, aged sixty-nine.

Current Topics and Events.

THE history of the discovery of insulin occupies an almost unique place in the scientific literature of recent times, and in the supplement which accompanies this issue we print an account of the present position of investigations regarding this substance. So many investigators had previously been within an ace of making its discovery that, as Prof. MacLean says, "it still remains a mystery why insulin was not isolated many years ago." The discovery is a good illustration of two salient facts bearing on scientific research work: first, that a very slight modification of a technique which had led previous explorers to failure might lead one to success; secondly, that research work of an applied nature, such as the search for a cure for diabetes, is very closely dependent upon related investigations which belong more properly to the domain of academic science—in this instance the improvement of methods for the accurate determination of small quantities of glucose in the blood. Insulin as now placed on the market is a therapeutically trustworthy preparation, and there must be many persons who owe life and health to the careful administration of this substance. But we must not be too sanguine that a diabetic taking insulin is to be regarded as a normal person. Prof. MacLean's article also contains a warning which it is to be hoped will be taken seriously to heart: careful investigation has shown that no beneficial results ensue from taking any pancreas preparation by the mouth, and this also applies to insulin itself, which is speedily destroyed by the juices present in the alimentary canal. From the academic point of view, insulin presents many problems of absorbing interest. At present the chief of these is the problem of what happens to the blood sugar and to glycogen after the administration of insulin: both apparently disappear, yet no intermediary or end products have yet been traced. Lastly, it cannot be too strongly emphasised that the discovery, from start to finish, could not have been made without those experiments on living dogs which some would seek to have abolished.

WHY it should have been left to Sir Douglas McGarel Hogg, Sir William Bull, and Sir Malcolm Macnachten to bring in "a Bill to confer certain powers on the Trustees of the British Museum," we have been unable to ascertain; nor can we discover whether the idea arose in the minds of those gentlemen spontaneously, or whether the seed was sown by some such body as the Museums Association. The Bill is, in brief, to empower the Trustees, under certain conditions, to lend for public exhibition in any gallery or museum controlled by a public authority in Great Britain, specimens falling under the graphic arts, jewelry, and "objects of art in gold, silver, bronze or crystal,"—a sufficiently curious selection. It proposes, therefore, an extension of the openings already made in the foundation Act of 26 George II., by which all objects entering the Museum were to "remain . . . to all Posterity." The Trustees have already obtained power to exchange, sell, or dispose of (7 & 47 George III.), as also to give away (41 & 42 Vict.), duplicate objects "not required for the purposes of the Museum"; but they have not as yet the power to lend. We do not know that they want it. If they are given it, we may rely on them to exercise it with due discretion. The British Museum is a storehouse to which there come by thousands inquirers from the uttermost ends of the earth. Such a student must not arrive in London to find that, of the objects he wishes to compare, one has been sent to Aberdeen and another to Penzance. There can never be any advantage in encouraging the British Museum to emulate the admirable Circulating Department of the Victoria and Albert Museum.

IN the *Times* of June 26 there was a somewhat sensational paragraph entitled "New anti-tuberculosis vaccine." It was stated that Prof. Calmette of the Pasteur Institute had, with various collaborators, discovered a new tuberculosis preventive. The further contents of the paragraph show that in its essence the discovery is not altogether new and has in part, at any rate, been referred to on more than one occasion, and most recently in the Annales de l'Institut Pasteur (xxxviii., 1924, p. 371). Calmette's vaccine is a living culture of tubercle bacilli which has been grown on a potato medium containing bile and glycerin for thirteen years. During this period it has become avirulent and is incapable of producing tuberculosis. It is claimed, however, that it is capable of establishing an immunity against virulent tubercle bacilli, and particularly so when injected into calves shortly after birth. The protection afforded by the avirulent bacilli lasts for more than a year. It is believed that the same results may be obtained in infants, and some work in this direction is briefly referred to in the *Times* paragraph.

IN NATURE of May 10, p. 685, we published a note on the alleged discovery of the long-sought virus of foot-and-mouth disease by Profs. Frosch and Dahmen of Berlin. From the reputation of these workers and their statement of experiments we were inclined to regard the discovery as correct, and this now appears to be so. In an article in the *Lancet* of June 28 considerable details are given of a lecture delivered by Dahmen and Frosch at Utrecht, and it is therein stated that a committee of six experts, including such well-known investigators as Titze, Giese, Kleine, and Gins, have been able to confirm the statements of Frosch and Dahmen, and that with subcultures of the virus in the sixth and twenty-sixth generation they had succeeded in reproducing the disease. On the assumption that the virus of foot-and-mouth disease has been discovered, it has been assumed by some that a royal road has been opened up for the prevention of the disease, but it is perhaps scarcely necessary to point out that this is not a corollary, for the establishment of immunity may not take place in spite of the presence of the virus.

THE annual conversazione of the Institution of Electrical Engineers held at the Natural History Museum, South Kensington, on Thursday, June 26,

was one of the most notable of a long series of annual functions in pleasant surroundings, due to the fact that it was held on the hundredth anniversary of the birth of Lord Kelvin, and formed a part of the group of centenary celebrations being held this summer in scientific and engineering circles, and to include, as we have already announced, the Kelvin Centenary Oration by Sir J. J. Thomson on July 10 and the Kelvin Centenary Banquet on the following day. A large company was received by the president, Dr. Alexander Russell, and Mrs. Russell and members of the Council of the Institution, and an excellent programme of vocal and instrumental music, in which Miss Phyllis Carey Foster took part, was provided in the Reptile Gallery, while the string band of the Royal Engineers performed in the Central Hall. Many distinguished engineers were present, and there must have been many there who remembered Lord Kelvin's regular attendance at these conversaziones in his later years.

It is of interest at the present time to recall that Lord Kelvin, Sir George Stokes, and Prof. Huxley were elected fellows of the Royal Society in the same year and on the same day, namely, June 5, 1851. Each of this brilliant triumvirate lived to receive the honour of the presidency, in 1883, 1885, and 1890 respectively The certificate of candidature of Lord Kelvin (William Thomson) was signed by Michael Faraday, John Couch Adams, and Adam Sedgwick, the distinguished Woodwardian professor of geology in the University of Cambridge. In retrospect, the support of Sedgwick is especially interesting since we know, through Sir Archibald Geikie, that from the year 1844 onwards for some eighteen years Lord Kelvin watched with increasing impatience the spread of the doctrines of the Uniformitarian School in geology, and at length, in 1862, "broke silence on the subject, declaring the doctrines of that school to be opposed to physical laws." It was one of the accepted tenets of the Uniformitarian School that the range of past time available for the explanation of the phenomena of geology was unlimited; but by arguments drawn from the origin and age of the sun's heat, the internal heat and rate of cooling of the earth, and the tidal retardation of the earth's rotation, Lord Kelvin fixed limits to the possible age of our planet. These have, of course, more recently been disputed. Lord Kelvin was always most punctilious in correspondence. Following the onerous engagements incidental to the celebration of his professional jubilee at Glasgow in 1896, he occupied himself on the way to London in writing autograph acknowledgments of the congratulation of friends. Not a few of his distinctive shorter papers were composed during railway journeys between Glasgow and London. In fact, wherever there was motion he found an atmosphere of calm, the hum of machinery acting as a mental stimulus. Mention may be made here that Lord Kelvin's portrait, by Orchardson, hangs in the Royal Society's meeting-room, the gift of a circle of fellows.

A TORNADO of hurricane strength swept over a fifty-mile stretch of the southern shore of Lake Erie in the afternoon of Saturday, June 28. According to the correspondent of the *Times*, three hundred persons are believed to have perished at Lorain, and the number of persons injured in the devastated track is estimated to be 2500. Many buildings are completely wrecked at Lorain, and in parts of the town it is reported that not a house was left standing. The principal destruction and damage occurred between Sandusky and Cleveland, and fear is entertained for some small passenger steamers plying on the Lake. The report states that the full extent of the damage will not be known for days. Earlier in the day, much havoc is said to have been caused by storms in the Upper Mississippi Valley. At Peoria, Illinois, hundreds of houses were unroofed and damage is reported from other places. The U.S. Weather Bureau will without doubt give details of the tornado. In the past, many such storms have been dealt with, notably by Finley and Ferrel.

IN view of some criticisms that have been made in Canada concerning Dr. V. Stefansson's recent geographical discoveries in the Arctic, attention may be directed to an article in the *Geographical Journal* for June. The Royal Geographical Society, on receiving from Mr. J. White, technical adviser to the Ministry of Justice, a detailed statement of the criticisms, submitted these to a searching examination by an impartial authority. All relevant original documents were consulted, including blue books of the various Franklin search expeditions, Sverdrup's charts of the adjoining regions, and Dr. Stefansson's own charts. A lengthy reply to Mr. White's letter, illustrated with charts, is published. Each point is examined in great detail, and the conclusions reached may be taken as final. They completely exonerate Dr. Stefansson of the charges that his discoveries of new land were anticipated by previous explorers, with the sole exception that Lougheed Island may have been sighted by Richards in 1853, but there was no suggestion of a land mass of the size of the island charted by Dr. Stefansson. The extensive islands now called Brock and Borden Islands were never suspected to exist. The Royal Geographical Society has done a service to polar exploration in disposing of these criticisms and establishing the validity of Dr. Stefansson's claims.

IN our issue of June 16, 1923, p. 818, reference was made to the formation of a committee to collect funds in order to commemorate the late Prof. A. D. Waller and Mrs. Waller. We understand that the fund has now reached a total of 1820*l*. and that a meeting of subscribers, probably a final one, will be held on July 5 at 5 P.M. at the London (R.F.H) School of Medicine for Women. It will be remembered that the fund is to be used for the promotion of scientific research and is to be administered by the council of the London (R.F.H.) School of Medicine, with which Prof. Waller and Mrs. Waller were associated for many years. It is hoped that the fund will reach 2000*l*. by the time of the meeting on July 5, and that it will then be possible to discuss the final form of the memorial.

THE staff of the Bombay Department of Agriculture interested in research into botanical and genetical problems has grown very considerably of recent years, and on April 14-16 the plant breeders of the Department held a conference in the Botanical Laboratories of the College of Agriculture, Poona, under the presidency of Dr. W. Burns, Economic Botanist to the Government of Bombay. An introductory address by Dr. H. H. Mann emphasised the need of attacking problems of economic interest in a truly scientific manner, and the subsequent proceedings of the conference, when methods of testing the performance of varieties of crop plants of economic importance were rigorously examined in the light of modern knowledge of statistical, botanical, and agricultural technique, suggest that Dr. Mann was preaching to the converted. Some forty specialists gathered at the conference, which was convened at short notice; they were drawn from the fifteen workers in the Government Plant-breeding Department, the five men working under the Sassoon David Trust, the Indian Cotton Committee investigators, and the staffs of the Economic Botanist and the Horticulturist. The conference also utilised the occasion to examine the experimental and demonstration plots conducted by the Poona College of Agriculture, of which Dr. Burns is Principal. At the close the conference recommended to the Director of Agriculture that such a conference should be held annually, and that next year it should meet in Surat.

THE influence of Joseph Leidy on science forms the subject of three interesting addresses delivered in December last at the Academy of Natural Science of Philadelphia and published in the *Scientific Monthly*, April 1924. The veteran Dr. Edward S. Morse said that in the midst of the rush for the description of new species, Leidy pursued his researches on the habits and anatomical details of creatures ranging from the protozoa to mammals, and his profound knowledge of the osteology of mammals enabled him to lay with a master hand the foundation for the palæontology of the reptiles and mammals of North America. Nearly a third of his published memoirs, extending over a period of forty years (1848–88), are on this subject. Prof. W. B. Scott reminded his audience that Leidy throughout his life was primarily interested in human anatomy and that he remained, almost to his death, professor of human anatomy in the Medical School of the University of Pennsylvania. Prof. Scott paid generous tribute to the value of Leidy's work in palæontology and geology. He stated that Leidy was the first to show that there were native horses and rhinoceroses in America, and he also found the first American camel. Prof. H. S. Jennings pointed out that Leidy seems to have attempted and carried out to a remarkable degree of success the project of forming for himself, and communicating partly to others, a detailed picture of the living world in relation to the environment. He was the better enabled to do this because of his artistic aptitude; indeed his work is largely a portrayal of Nature as seen by a thorough scientific artist, of which his great memoir on the fresh-water rhizopods is an outstanding example.

WE learn from *Science* that Prof. J. C. McLennan, of the University of Toronto, has been elected president of the Royal Society of Canada.

THE Agricultural and Horticultural Research Station of the University of Bristol will be open to visitors on July 15, when the experimental work in progress will be demonstrated by the staff.

MR. E. E. AUSTEN has been appointed deputy keeper in the Department of Entomology of the British Museum (Natural History), South Kensington.

THE Franklin Institute of the State of Pennsylvania for the Promotion of the Mechanic Arts was incorporated on March 30, 1824. The centenary, therefore, falls due this year, and will be celebrated on September 17-19.

APPLICATIONS are invited for two assistantships at the Solar Observatory of the Commonwealth of Australia. They should be sent to reach the High Commissioner for Australia, Australia House, Strand, W.C.2, by, at latest, July 31. Further particulars are obtainable upon request.

MR. E. R. D. MACLAGAN has been appointed by the President of the Board of Education to succeed Sir Cecil Harcourt Smith, who will retire from the position of Director and Secretary of the Victoria and Albert Museum in September next. Mr. Maclagan has been deputy keeper of the Department of Architecture and Sculpture in the Museum since 1921.

THE Imperial Botanical Conference opens at the Imperial College of Science and Technology, South Kensington, on July 7, under the presidency of Sir David Prain. A large number of overseas and British botanists have signified their intention of attending the Conference, for which an attractive programme has been arranged.

THE Safety in Mines Research Board is in need of the services of a number of abstractors—men or women—able to make rapid and accurate translations (abstract or full) from German and French scientific publications. Applications for the posts, giving full particulars of qualifications, etc., should be addressed to the Under Secretary for Mines, Mines Department, Dean Stanley Street, S.W.1, not later than July 19.

A GOVERNMENT chemist is required for service in Fiji, largely in connexion with the agricultural department. Candidates should, if possible, be University graduates; they must be associates and fellows of the Institute of Chemistry, and have had experience of the work of a public analyst. Requests for forms of application and for further particulars should be addressed in writing to the Private Secretary (Appointments), Colonial Office, Downing Street, S.W.1.

A DECIMAL-METRIC Conference has been arranged by the Decimal Association and will be held on July 9 in the house of the Institution of Electrical Engineers. The subjects to be discussed are decimal coinage

with special reference to the ten-penny shilling, and piecemeal proposals for introducing metric weights and measures. Among the speakers will be Sir Robert Horne, Sir Robert Hadfield, Sir Napier Shaw, Mr. Harold Cox, Mr. Gordon Selfridge and Mr. Felix Blakemore. A number of chambers of commerce and other public bodies in the Dominions Overseas are sending delegates, and representatives from the United States will also be present. In connexion with the Conference a visit to the National Physical Laboratory, Teddington, has been arranged for July 10

AT a meeting of the Botanical Society of Edinburgh, to be held at the Royal Botanic Garden, Edinburgh, on July 17 and 18, demonstrations and communications on various aspects of vegetative plant propagation are to be given. At the morning sessions of the meeting, numerous illustrations of the methods and results of propagation from stem, leaf, and root, will be presented, while the afternoon sessions will be devoted to the reading of papers and to a general discussion of the exhibits. The following papers will be read: (1) The propagation of clematis, by Miss Edith Philip Smith; (2) on cuttings of camphor, by Miss Oona Reid, (3) horizontal branch propagation, and (4) root cuttings, by Mr. L. B. Stewart; (5) propagation by bulb scales, by Dr. R. J D. Graham

THE Egyptian Government Almanac for 1924 (Cairo. Government Publications Office, 1924; price 10 P.T.) maintains the high standard of usefulness of former editions. It contains a good deal of statistical matter, but aims rather at being explanatory and descriptive. Matters of scientific interest include some papers on the geographical features of Egypt and a useful article on the Nile, its tributaries and water supply. There are notes on the survey of Egypt, the antiquities department and the physical department, including a summary of meteorological data. The section on agriculture and industries is particularly full.

MESSRS. H SOTHERAN AND CO., 140 Strand, W C 2, and 43 Piccadilly, W.1, have just issued No. 789 of their "Price Current of Literature," being No. 3, Pt. 4, of their "Catalogue of Science and Technology," and comprising the titles and bibliographic details of some hundreds of books relating to physics, many of which are rare and of great interest and importance A valuable list of works by, and respecting, Sir Isaac Newton is included. The catalogue should appeal to all students of physics.

ERRATUM.—In announcing the award of a Research Prize of 1000 dollars to Dr. Mary Evelyn Laing in NATURE of June 28, p. 935, it should have been stated that the award referred to is the Ellen Richards Research Prize for 1924

Our Astronomical Column.

EYEPIECES USED BY SIR WILLIAM HERSCHEL.—It is well known that Sir William Herschel stated that at times he used eyepieces giving magnifying powers in the neighbourhood of 6000. The eyepieces themselves seem to have been lost sight of after his death, and considerable scepticism as to the reality of these powers was expressed by subsequent writers But recently, Dr. W. H. Steavenson, who was making by request a thorough examination of the Herschel instruments at Slough, found the eyepieces in question, and measured their powers with a dynamometer. He found values agreeing within 10 per cent. of those stated by Herschel, the highest power being well over 6000. This was naturally a single lens, $\frac{1}{50}$ inch in diameter. From a highly enlarged photograph the lens was seen to be not a natural spherical drop, but carefully figured. The curves were hyperbolæ rather than circles, and the two sides were not quite symmetrical, but Dr. Steavenson found that he could get fair definition on a portion of Saturn: the diameter of the well-defined region was only 26″, so that it must have been excessively difficult to keep objects in the field without equatorial mounting. It is satisfactory that Sir William Herschel's accuracy of statement is once more vindicated.

MINOR PLANETS.—The observation of these bodies, which was greatly interrupted by the War, is now once more in full swing. Several interesting objects have been detected in recent months. *Astr. Nach.* No. 5293 contains a study of the special perturbations by Jupiter and Mars of 132 Aethra, by Mr. C. J. Merfield, of Melbourne Observatory. He gives osculating elements for the oppositions of 1924, 1925, 1926, together with an accurate ephemeris for the next few weeks. This body was found by Watson in 1873, and was then lost for fifty years, being recovered in December 1922.

Astr. Nach. No. 5292 contains some observations of Eros made at Berlin-Babelsberg last autumn, its magnitude being 9·6. The planet afterwards went southward, and its observation was continued at Johannesburg. Dr. Witt, its discoverer, is engaged on a careful study of its perturbations, in order to predict the conditions of its near approach to the earth in January 1931. These recent observations will be very useful, as the planet was fairly near the earth

The last assignment of numbers to recently discovered planets extended to No 995. As many have been discovered since, the next numbering, in a few months' time, will undoubtedly extend beyond 1000. It should be noted that the number of those known to exist, but not all observed sufficiently for definite numeration, passed 1000 several years ago.

REPORT OF THE CAPE OBSERVATORY.—Dr. H Spencer Jones, recently appointed H M. Astronomer at the Cape, has just issued his first annual report Besides the usual meridian observations, heliometer comparisons of the major planets with neighbouring stars are being made regularly. These have a considerably smaller probable error than meridian places, so will ultimately be very useful for improving the tables of these bodies.

Stellar spectrographs have been taken with the Victoria telescope for the measurement of radial velocities. Many plates have also been taken for proper motions both with this telescope and the astrographic: they are examined by Dr. Innes with the blink micrometer. Messrs. Long and Skjellerup, two voluntary observers, used the small equatorials for the study of 60 variable stars, obtaining more than 140 observations.

Dr. Halm is continuing his studies on stellar masses and luminosities. He suspects that the masses are grouped round the values 6·5, 3·3, 1·6, 0·8, in terms of the sun; they appear to form a geometrical progression. Further details are promised shortly.

Wireless time-signals for the use of ships are sent from the Observatory to Slangkop, where they are automatically distributed.

Research Items.

Population and Environment.—Dr. S. M. Shirokogoroff has published, through Messrs. Edward Evans and Sons of Shanghai, under the title "Ethnical Unit and Milieu," a valuable study of population problems, in which he lays down a number of propositions supported by examples drawn mainly from his studies of the peoples of north-eastern Asia. In a community, if an increase of population exceeds the possibility of nourishment, the excess of population must perish or the natality must be regulated by some means, medical, artificial, social, etc. Increase of population is regulated by the extent of territory and by the growth of culture, the more intensive the exploitation of territory, the larger the population it may nourish, as, for example, in an agricultural as contrasted with a hunting community. Maintenance of the level of numerical value must be understood relatively to the variation of culture and territory, a conclusion which has a direct bearing upon the question of degeneracy and decline of any given people. Variation of some aspects of the cultural complex is followed by variation in the whole complex and entails a period of cultural disequilibrium. Physical degeneracy may be either a process of extinction or a substitution of one anthropological type for another; in both cases there is an ethnical disequilibrium. Limitations being imposed upon the possibility of variation in the factors of culture, territory and density of population, which are interdependent, the general conclusion follows that there will be a degeneration or decline and an end of the present species of man. It is probable that the greater part of the way to absolute density of population is already covered, and that mankind is at present near its culmination.

The Mother Goddess in Egypt.—In No. 11 of the Journal of the Manchester Egyptian and Oriental Society, Mr. John Lewis analyses certain forms of Egyptian belief with the view of showing that they point to conceptions associated with the cult of a Great Mother Goddess such as Prof. Elliot Smith has postulated to lie at the root of primitive and early religion. Mr. Lewis compares the graffiti of the rocks at Gebel Hetematt, Wady Hammanat, and Selsileh, and the paintings of the prehistoric tomb near Hierakonpolis, with the cave drawings of France and Spain, and from their similarity deduces that they are based upon identical magical ideas connected with food and protection. The statues of the god Min, at one time a female deity, link up the ideas of water, the life-giving element, the shell, which is the life-giving female deity, procreation, the mother-deity and the father-deity. The girdle of Hathor-heads on the slate palette of Narmer is a development of the shell-girdle, the strength of Hathor-Isis, which connects the shell-deity with Hathor

Oriental Prehistory.—M. J. de Morgan contributes to *l'Anthropologie*, t. xxxiv. 1-2, the first of a series of articles on the prehistory of Western Asia and Egypt. In neolithic times, possibly from late quaternary times, it is suggested as a working hypothesis that the areas under consideration were inhabited by four races—in the north a white Caucasic race, of which traces may perhaps still be found in the remote mountain districts of the Caucasus; in the south, stretching from Elam to the Mediterranean, a negrito race related possibly on one side to peoples living in the Indian Peninsula, on the other to the inhabitants of the European caves; in Egypt and North Africa, Berbers; and Semites in Arabia. This multiplicity of races at this stage throws no light upon the question of origins. That part of Western Asia, of which the country of the Euphrates and Tigris—the cradle of civilisation—is the centre, is cut off from the rest of the world. It contains three types of geographical areas, a mountain region, plateaus, and plains. An examination of the geological conditions from early quaternary times indicates that Chaldæa, lying between mountains and plateaus with their cold and humid climates and the hot dry desert area, alone afforded conditions suited to man in early times, and this owing to the fact that it was watered by two rivers. The plateaus did not become habitable by man until he possessed domesticated animals capable of subsisting on pasture land.

Animal Life in Deserts.—In the Proceedings of the Royal Society, B, vol. 96, 1924, pp 123-131, Mr. P. A. Buxton records the results of some investigations made in Palestine on the relations of temperature and moisture to animal life in deserts. This observer finds that the soil surface commonly reaches 60° C. at midday, and certain insects are active upon it even at that temperature. Their body temperature is lower than might be expected, probably owing to loss of water during respiration. An interesting point is that the black form of a dimorphic grasshopper has a body-temperature 4-5° higher than the buff form, when exposed to the sun. If the loss of water hypothesis be correct the insect's need for water is greater than is commonly believed. Deserts have a great diurnal range of temperature and of relative humidity. The night air is often almost or quite saturated with moisture, while by day the humidity may drop to 20 per cent. It appears that the desiccated fragments of the annual vegetation are hygroscopic: that they take up a considerable proportion of water from the moist night air and hold it for several hours after the sun has risen The author believes that this property of the dried pieces of grass and herbage is one of the foundations which support all animal life in deserts during summer. These fragments, with the moisture absorbed over night, are eaten by certain insects which in turn become a source not only of food but also of water, for the birds, lizards, predaceous insects, and other carnivorous animals.

Symbiosis between Termites and their Intestinal Protozoa.—L. R. Cleveland has given further details of his work on the symbiotic relationships between the intestinal protozoa of termites and their host (*Biol. Bull*, vol. 46, pp. 177-225, 1924). The protozoa principally concerned are flagellates—Trichonympha and related forms. By incubating termites at 36° C for 24 hours (a method due to Grassi) the flagellates are killed, but the termites are uninjured. If such "defaunated" termites are given their normal diet of wood, they eat quantities of it, but they become less active and die within three or four weeks. If "defaunated" termites are placed with ordinary ones, the former—by feeding on the fæces of the latter—become reinfected with protozoa, and after about ten days regain the ability to utilise wood and can live indefinitely. When termites were starved, the wood-ingesting protozoa in their intestine died within eight days, and the termites when returned to a wood diet lived only a few weeks. These and other examples emphasise the close correlation between the wood-feeding habit and the presence of protozoa That the latter use the wood as food and not the intestinal fluids of their host is

proved by direct observation—numerous wood particles are present in the posterior portion of Trichonympha—and by the fact that these protozoa die ten to twenty days before their host when wood is withheld. In normal-feeding termites a large percentage of the wood which they have eaten may be found in the protozoa, and in termites starved for a few hours it is almost impossible to find any wood particles in the intestine, they have all been ingested by the protozoa and the particles gradually disappear. A large amount of glycogen is present in these protozoa produced by digestion of the wood. The termites furnish food and lodging to the protozoa, and the latter provide products formed by digestion of the wood—a clear case of symbiosis. The young termites feed on excreta loaded with flagellates, so that they are practically certain to become infected, and then they begin to eat wood.

Mass Relations of Cytoplasm and Nucleus.—Prof. R. W. Hegner brings together (*Scientia*, June 1924) evidence from his observations on Arcella and Opalina and from those of other investigators on protozoa, in regard to the mass relations existing between cytoplasm and chromatin, and concludes that the following generalisations are reasonably established: At each stage in the life cycle of these organisms there is a fairly definite amount of cytoplasm associated with each nucleus. The size of the nucleus is an indication of the amount of chromatin contained within it; the amount of chromatin is the real factor involved in the ratio of nucleus to cytoplasm. Nuclear division is initiated by an increase in the amount of cytoplasm as compared with that of the nucleus.

Vitality of Pollen Grains.—Mr. S. Nohara (*Japanese Journ. of Botany*, vol. 2, No. 1) has made an experimental study of the pollen in several species and hybrids of Salix. Germination of the pollen was most successful in 2-5 per cent. sugar solution, beginning very quickly, and the pollen tubes attaining a length of 4-8μ in half an hour. Tests of the longevity of pollen showed that it was much affected by temperature, humidity, and light, and that its germinating power could be maintained for seventy days in a dry, cool, dark place. Temperatures so low as 21° below zero for 8 hours do not lessen the germinating and fertilising power, while a temperature so high as 37° kills the pollen. Chloroform vapour terminates the germinating power of pollen in 4-5 hours, and ether vapour in 20 hours. In certain hybrids between *Salix viminalis* and *S. multinervis* the pollen and seeds were nearly normal, but the catkins showed various intersexual conditions.

Botanical Notes from Ceylon.—The Annals of the Royal Botanic Gardens, Peradeniya, vol. viii., May 1924, is mainly contributed by Mr. T. Petch, Government Botanist and Mycologist, Ceylon. A long paper upon the insect catching proclivities of the flowers of species of Aristolochia cultivated in Ceylon includes a record of their insect visitors so far as identification of the tropical insects had proved possible. Mr. Petch concludes that the flies are attracted to the flowers by their odour, which is offensive in *A. gigas*, but in some species, such as *A. ridicula* and *A. elegans*, is not detected by man's senses. The flies then seem to enter the tube of the flower by accident, and are prevented from crawling out by the inwardly and downwardly directed hairs, until later these hairs wither. One interesting conclusion from the record of insect visitors is that the hooded type of flower, which is regarded as primitive, is the most effective in attracting and trapping insects; the striking bizarre forms, such as *A. ringens*, attract few flies, so that "the advantage of a further evolution in the direction taken by these extraordinary forms is not obvious." Mr. Petch also describes the species of Xylariaceæ recorded for Ceylon up to the present date (pp. 119-166), and has a note upon extraordinary forms of fructification extending the range of variation recorded for Diplodiella. Mr. C. Ragunathan confirms the occurrence of teleutospores in *Hemileia vastatrix* B. and Br., the coffee leaf disease; they were previously recorded by the late Prof. Marshall Ward, but have not been seen by subsequent investigators.

Origin of Tinstone.—Bulletin No. 5 of the Geological Survey of Nigeria, by Mr. C. Raeburn, deals with the tinfields of Nassarawa and Ilorin Provinces (London: Crown Agents for the Colonies, 1924. 10s. net.) It describes two separate areas in considerable detail and discusses the origin of the tinstone, which it says "is due to pneumatolytic action on the granite and gneisses near their contact. This gives rise to greisen, usually containing topaz and tin, and carrying networks of quartz veins with tinstone, and at times to a complete replacement of the rock in the direction of topazisation or micasisation. As regards that part of the tinstone which is related to the pegmatites, it must be emphasised that it, both in point of time and manner of origin, is quite different from the other. On the one hand we have tinstone as an original constituent which had already commenced to crystallise before the intrusion of the rock; on the other we have tinstone as a later mineral formed by pneumatolysis after the intrusion and solidification of the granite."

Zirconium and Hafnium Ores.—The results of some analyses of zirconium ores by G. Hevesy and V. T. Jantzen are published in the *Chemical News* for May 30. Malacon from Madagascar and from Hittero is particularly rich in hafnium, the former containing so much as 7 per cent. and the latter 5 per cent. of hafnium oxide. Three out of four specimens of thorteveitite showed a higher hafnium than zirconium content. The superior radioactivity of ores with a high hafnium-zirconium ratio over that of the more abundant zirconium ores is due to the presence of uranium and thorium oxides.

Meteorological Data over the Oceans.—From various sources the Royal Netherlands Meteorological Institute has produced some useful tables of monthly meteorological data over the oceans for the year 1921 (Bulletins 6^1 and 6^2). The computations are for ten-degree squares and give the mean force and direction of the wind, the atmospheric pressure, air and water temperature, and cloudiness. In the Atlantic Ocean the data are given between 5° to 25° N. and 25° to 45° W. and between 0° to 20° S. and 10° E. to 10° W.; in the Indian Ocean between 10° and 20° N. from 70° to 90° E. and between 10° and 30° S. from 90° to 110° E.; while in the Pacific Ocean the limits are 10° to 30° N. and 140° to 160° W., and 10° to 20° S. and 90° to 110° W. The observations thus leave out of account large areas of the oceans especially in high latitudes, and are not complete in many parts of the Pacific Ocean within the limits given. But they can of course be obtained only on frequented trade routes. The number of observations in each month varies in different squares from one to more than a hundred. The corresponding data for 1917–1920 consisting only of Dutch observations are promised shortly.

Free-Air Temperatures and Wind Directions.—The *Monthly Weather Review* for January, published by the U.S. Weather Bureau, has an article by Mr. W. R. Gregg showing the relations between the above.

The purpose of the discussion is to utilise, for the advancement of the subject, the available free-air observations made in the United States from 1915 to the present time. All observations made with kites are considered, but the discussion is chiefly confined to data from Drexel, Nebr., and Ellendale, N. Dak. Observations of wind and temperature are grouped for 16 points of the compass for the surface, and for one, two, three, and four thousand metres above sea-level for each station, also for spring, summer, autumn, winter, and the year. The observations with N.N.W. to N.N.E. and S.S.E. to S.S.W., with distinctly north and south components, are separately combined for each elevation. At all levels to at least 4 kilometres much higher temperatures prevail with south component than with north component surface winds. Differences are smallest in summer, averaging about 5° C. The differences are greatest at 1 and 2 kilometres, but at 4 kilometres they average 7° to 8° C. It is pointed out that the free-air position of a low barometrical centre is usually to the north-west of the sea-level position, and that of a high to the south-west, so that winds are south-westerly above the sea-level positions of lows and north-westerly above the sea-level positions of highs, and consequently the air above lows is warmer than that above highs. Taking the lowest and highest pressures at different heights as the basis of comparison, it is found that the lowest pressures are accompanied by the lowest temperatures, the pressure itself at any level being largely a function of the mean temperature of the air column beneath. Numerous examples and charts are given, showing the influence of the source of air supply on the changes of temperature experienced during the passage of areas of low and high barometer. The discussion is of great value to experimental meteorology.

ADSORPTION.—Since Gibbs deduced an equation for the change of concentration of a dissolved substance at the surface of separation of its solution from another material, in terms of the rate of change of surface energy with concentration, attempts have been made to test its validity by experiment. The most successful experiments up to the present were those of Donnan and Barker in 1911. J. H. Mathews and A. J. Stamm, in the May number of the Journal of the American Chemical Society, describe experiments at a liquid-liquid interface, using a drop-weight method. Solutions of dimethylaniline in heptane and in benzene were used. The qualitative results confirmed Gibbs' formula, and by calculation from the quantitative results Langmuir's theory of adsorption was found to be verified, namely, the adsorption is one molecule thick up to concentrations where a complete surface layer is formed. The molecular thicknesses and cross-sections agree with those of other investigators

APPARENT SELECTIVE REFLECTION OF X-RAYS BY CRYSTALS.—Dr. W. Kossel, in the *Zeitschrift fur Physik* for May, deals with the observations of Clark and Duane, which these authors have interpreted as indicating selective reflection. Kossel points out that, according to the ideas of the mechanism of radiation held up to the present, a coherence between the radiation of separate atoms, such as is required to explain selective reflection, is not to be expected, since the times during which they are excited are supposed to be irregularly distributed. He finds it possible to explain a good deal of the experimental material of Clark and Duane, in part quantitatively, by considering the variations of the absorption coefficient of the crystal. X-rays of wave lengths for which the coefficient of absorption is small penetrate to a greater depth into the crystal than those for which it is large, and stronger interference effects are produced by the crystal lattice with the first than with the second. It seems doubtful whether any new phenomenon, which can be described as selective reflection, is involved.

MAGNETON NUMBERS AND ATOMIC STRUCTURE.—It is interesting to note that a certain amount of scientific work is still being carried out in Russia. Dr. J. Dorfmann contributes a paper, dated from Leningrad, to the May issue of the *Zeitschrift für Physik*, in which he puts forward a series of hypotheses as to the relation between the electron orbits of the elements, and their magnetic properties Bohr has shown that atoms with a closed electronic configuration, where the orbit groups contain 2, 4, 6, 8 similar n_k orbits, are diamagnetic; and that paramagnetism appears when they contain 1, 3, 5, 7 orbits. If there is only one electron in an orbit group, the magnetic moment due to it is given in Bohr units, by the k number of the orbit; the author assumes that, with a group having 3, 5, 7 or $2p+1$ orbits, $2p$ of them form a symmetrical diamagnetic complex, while one of them takes part in the paramagnetism, and contributes a moment of k units to the atom The moments due to different asymmetrical orbit groups are supposed to add, when the principal quantum number n is the same for all the groups concerned; while for different values of n they are regarded as combining vectorially. Orbit configurations have been worked out for different ions of the elements between scandium and zinc; and values of the magnetic moments have been calculated, on the above assumptions, which agree quite well with the observed values. A similar table is given for the elements from lanthanum to hafnium, for which, however, the observational data are not quite complete.

STEAM-NOZZLES.—The third report of the Steam-Nozzles Research Committee has now been presented to the Institution of Mechanical Engineers, and comprises (*a*) tests on convergent impulse nozzles, 20 nominal angle, with thick partition plates; (*b*) a series of tests to determine the effect of chamfer on the exit edges of comparatively thick plates; (*c*) work on the ⅜-inch Parsons standard 430 B blades, which emphasises the effect of entry on nozzle efficiency, (*d*) the first test results of a set of straight elementary nozzles designed by Prof A. L Mellanby. The general shape of the curves obtained for the velocity coefficients of steam-nozzles (given in the second report) has been corroborated, and in one or two cases the curve has been carried sufficiently far into the low velocity region to indicate that it "turns over" as predicted by Mr. Martin. The effect of chamfering thick plates of convergent nozzles is clearly shown in the present report; it would appear that a thick plate nozzle with a chamfered exit can be made as efficient, over a considerable working range, as a nozzle with very thin plates. A straight elementary nozzle is in general 5 per cent. more efficient than the practical types of nozzles which have been tested. A review of both second and third reports goes to show that the condition of entry or of exit is important; the steam should approach the nozzle as smoothly and as slowly as possible, and no flat surfaces should be left on the exit side of any nozzle. There are other interesting conclusions on the effect of superheat, for which reference should be made to the report. The work of the committee is proceeding without interruption, and has been greatly assisted by contributions from the British Electrical and Allied Industries Research Association.

International Conference on Soil Science.

THE fourth International Conference on Soil Science was held in the building of the International Institute of Agriculture at Rome on May 12-19, when between 120 and 150 delegates from various countries were present. The Ministry of Agriculture appointed the following delegates from Great Britain: Dr. N. M. Comber, Dr. B. A. Keen, Mr. H. J. Page, and Mr. G W. Robinson.

The general organisation of the conference was in the hands of Prof. Hissink, of Groningen, Holland, and the actual arrangements for the meeting were carried out by local committees in Rome.

In all, some 250 papers were presented to the conference, distributed over the following sections:

1. (*a*) Physical Properties, and Mechanical Analysis of Soil.
   (*b*) Application of Soil Science to Field Conditions.
2. Chemical Properties of Soil.
3. Biochemical and Bacteriological Studies.
4. Soil Classification
5. Soil Surveys and Maps.
6. Physiological Studies in Relation to Soil.

These sections met both independently for the consideration of their own papers, and jointly for discussions of common interest.

In addition, the following lectures were given during the conference:

La nitrification et ses conséquences agricoles, Prof G. André (Paris). Recent Advances in Soil Physics, Dr. B. A Keen (Rothamsted), Dispersoidchemie und Bodenkunde, Prof G. Wiegner (Zurich), Die modernen Ziele zur Erforschung der Bakterientatigkeit im Boden, Prof. J Stoklasa (Prague); The Fertiliser Industry of the United States in Relation to Soil Science, Prof. J. G. Lipman (New Jersey); Analisi del terreno e suo valore, Prof. A. Menozzi (Milan)

Some considerable time before the conference, arrangements had been made for certain outstanding questions to be studied co-operatively by workers in different countries. The reports of these investigations formed an important section of the conference. Among them may be mentioned an investigation of the various methods employed for dispersing soil samples prior to a mechanical analysis. Samples of two given soils were distributed to each worker so that the results of the various methods were strictly comparable. The mechanical analyses showed considerable variations, not only among the different methods, but also for the same method in the hands of different workers. The studies are to be continued and extended in view of the vital importance of complete dispersion of the soil suspension for the newer methods of mechanical analysis, such as those of Odén and Robinson, which depend on one single sedimentation.

Further joint discussions took place on the question of base exchange in soils and on the production and cause of soil acidity. It cannot be said that any general agreement emerged from these discussions, nor in the present state of our knowledge would this be expected. The contributions of Ramann and Wiegner on base exchange were noteworthy. The former supported the view that base exchange alone is produced by neutral salts; hydroxides and salts with alkaline reaction give base exchange and adsorption; acids and acid salts decompose the silicates, and an exchange between the cations of the silicates and the hydrogen of the acids causes the formation of acid soils. Wiegner developed the view that base exchange in clay or soil is a special case of the so-called "polar" exchange-adsorption, and is intimately linked up with the degree of dispersion of the clay. On this view a clay particle may consist of an aggregate of smaller particles. The total surface of the compound particle is available for base exchange phenomena, while the electrical properties of the aggregate are a function of its outer surface only.

All the six sections combined for the discussion on soil acidity. The chief value of this discussion, which extended over too wide a range for an adequate summary to be given here, was the opportunity afforded for those studying the subject from the physico-chemical aspect to appreciate the problem from the physiological point of view, and vice versa. A number of the speakers dealt with the efforts made to develop a field technique on which practical recommendations as to liming could be based. Prof. Hissink described his quantitative adaptation of the well-known Comber test for sour soils that was now in extensive use in Holland as a means of measuring lime requirement. Dr. Comber directed attention to the danger in assuming that any qualitative test that showed a reasonable degree of quantitative relationship for any given soil type was suitable for general application.

Special mention must be made of the work of Section 5. In the face of considerable difficulties, financial and otherwise, a very complete account of the present position of soil survey work was collected from experts in many different countries. With the assistance of the Geological Institute of Rumania, Bucharest, Profs. Murgoci and Opresco were able to have these memoirs printed for distribution to the conference. The volume forms a most valuable record of the present state of the subject, and will be of great value for comparative studies.

In connexion with the conference, a small exhibition of apparatus, maps, etc., was held. Several members took this opportunity of demonstrating the apparatus they had already described at the conference. The younger German workers are showing considerable activity in devising field instruments. The problem of measuring the moisture content of soils *in situ* by means of the electrical resistance has been attempted before, but the apparatus was not satisfactory. The new method of Dr. Götz, of Berlin, is based on the same principle, but is a distinct improvement and appears to be of great promise. Dr Trenel, of Berlin, demonstrated an apparatus for measuring the P_H of soils *in situ*.

Perhaps the chief value of a conference such as this lies not so much in the meetings and reports as in the numerous opportunities afforded for informal discussions with workers from other countries. The conference was well served in this respect, as the local committee arranged several receptions and excursions during the meeting. The Italian Government took an active interest in the proceedings; the King was present at the opening of the conference, and the Minister of National Economy attended the closing meeting

The final act of the conference was to establish an International Society of Soil Science, having as objects the promotion of soil science by means of conferences, the formation of special committees for co-operative work, the publication of a review, and the institution of a central office in the International Institute of Agriculture at Rome, where all reports and documents can be filed, and from which members can obtain information needed in their work.

The first president is Prof. J. G. Lipman, of the New Jersey Experimental Station, and on his invitation, the conference appointed America as the place for the fifth meeting. The following were elected

honorary members Prof. Cayeux (France), Prof. Glinka (Russia), Prof. Murgoci (Rumania), Prof. Ramann (Germany), Sir John Russell (England), and Prof. Winogradsky (France) The acting-chairman and general secretary is Prof Hissink, Groningen, Holland. The International Mitteilungen für Bodenkunde has been taken over as the official journal of the society, and will be in future published by the International Institute of Agriculture at Rome.

The society has undoubtedly an important future, and it is hoped that it will have many British members. Further information can be obtained from either Prof. Hissink or Dr. B. A. Keen, Rothamsted Experimental Station, Harpenden B. A. KEEN

International Mathematical Congress.

DURING next August, Toronto is to be the scene of two great scientific gatherings. The British Association will hold its ninety-second annual meeting on August 6-13, and an International Mathematical Congress will be held on August 11-16. International gatherings of mathematicians have previously been held in Zurich (1897), Paris (1900), Heidelberg (1904), Rome (1908), Cambridge (1912), and in Strasbourg (1920). The North American continent is for the first time the meeting place of such an assembly. The natural boundary of distance, with the incident expense of transportation, is being in a large measure overcome by the generosity of the Governments of the Dominion of Canada and the Province of Ontario, each of which is making a contribution of 25,000 dollars to defray the expenses of the Congress. The greater part of these funds will be used to assist the passage of eminent European men of science, mathematicians, and representatives of those sciences and professions which apply mathematics It is estimated that the attendance from Europe will exceed one hundred and fifty. The British representation on the applied side promises to be large. At least twenty will come from France, nearly as many from the Scandinavian countries, and more than a dozen from Italy. Not less than fifteen European countries will be represented. The attendance from Canada and the United States is expected to run into the hundreds.

Difficulties in arranging suitable dates for the Congress delayed the sending out of notifications. The Organising Committee has tried to notify all those likely to be interested resident in countries adherent to the International Mathematical Union, or eligible for adherence thereto. In all, some six thousand notifications have been sent out, and a large number of universities and learned societies have been invited to be represented by delegates. Among those bodies which will be represented are the National Committees of the International Mathematical Union. These Committees are, as a rule, appointed by the National Academies of the respective countries, and through them the Academies might be regarded as obtaining representation Many of the Academies, however, will, in addition, be directly represented. This, for example, will be the case with the Reale Accademia dei Lincei and the Académie des Sciences de l'Institut de France. Many specialised scientific societies too have named delegates. Among such are the Société Mathématique de France, the Circolo Matematico di Palermo, the American Mathematical Society, the Physical Society of London, the Société Française de Physique, the Royal Astronomical Society, the Royal Meteorological Society, and sister societies in a number of different countries. Statistical and actuarial societies will also be represented The Institution of Naval Architects, the Institution of Electrical Engineers, the Institution of Mechanical Engineers, and other engineering organisations have appointed representatives. The same is true of the British Association and the corresponding organisations in France and the United States. The National Physical Laboratory and the Bureau of Standards have also named delegates, while many universities will be represented, including, among others, Cambridge, Paris, and Rome.

The Congress is being held under the auspices of the University of Toronto and the Royal Canadian Institute, and will be conducted in accordance with the regulations of the International Research Council. Prof. J. C. Fields, president of the Royal Canadian Institute, is chairman of the Organising Committee, and the other members of the Committee are Sir Robert Falconer, president of the University of Toronto, Prof. A. T DeLury, Prof. J. C. McLennan, Prof. C. A. Chant, Mr. T. H. Hogg, Dr. J S. Plaskett, Prof. M. A. Mackenzie, Prof. E. F. Burton, Mr. J. Patterson, Mr. W. P. Dobson, Wing-Commander E. W. Stedman, and Prof. J. L. Synge (secretary). Dr. F. A. Mouré, bursar of the University of Toronto, is acting as treasurer. An Editorial Committee has been organised, with Prof Fields as chairman. There are also associate committees to deal with hospitality, excursions, printing, publicity, meeting rooms, signs and messengers, finance and transportation.

An excursion has been arranged for a selected party to the Western Provinces on special trains, leaving Toronto on the night of Sunday, August 17, and returning in about three weeks' time. There will also be an excursion through Northern Ontario, and excursions to Niagara Falls on August 9 and August 16, the route being by steamer across Lake Ontario, the journey each way taking about two hours.

The Congress will meet in the following sections:

Section I Algebra, theory of numbers, analysis.
Section II Geometry
Section III. (a) Mechanics, mathematical physics.
(b) Astronomy, geophysics.
Section IV. (a) Electrical, mechanical, civil and mining engineering.
(b) Aeronautics, naval architecture, ballistics, radiotelegraphy.
Section V. Statistics, actuarial science, economics.
Section VI. History, philosophy, didactics.

It will be observed that this scheme of sections differs from those adopted at former congresses in the additional attention devoted to the applications of mathematics. It has been devised in order to secure in the sphere of applied mathematics full opportunity for consideration not only of those questions the interest of which is purely scientific, but also practical problems of engineering the solutions of which contribute directly to the cause of material progress.

The Organising Committee would be obliged if those who expect to attend the Congress would notify the secretary to that effect, stating their order of preference in accommodation from a choice of hotel, boarding-house, or university residence. Abstracts of papers intended for presentation should be in the hands of the secretary well in advance of the meeting.

Further information may be obtained from Prof. J. L. Synge, secretary of the Organising Committee, International Mathematical Congress, Royal Canadian Institute, 198 College Street, Toronto, Canada.

The Physical and Physico-chemical Problems relating to Textile Fibres.

IN the joint discussion held by the Faraday Society and the Textile Institute at the British Empire Exhibition, Wembley, on June 11, under the presidency of Sir Robert Robertson and Mr Lester, a number of important developments of research on textile fibres was disclosed. The papers covered a wide field and dealt with the physical properties of cotton, wool, flax, and silk fibres. It is intended in this article to describe some of the points raised during the discussion rather than to refer in detail to the subject-matter of the papers, which is to be published later.

The introductory address was given by Dr W. L. Balls, who proposed to divide physical research in textiles into two sections: (1) that relating to the physical unit in each raw material, and (2) that relating to the larger field concerned with the building up of the yarn and fabric. The appropriateness of this division is at once apparent, it separates, at least vaguely, the bio-physical problems from the mechanical ones, implying by the latter those problems concerned in the transformation of a mass of raw material into a useful yarn or fabric. In his conclusion Dr. Balls said: "The defects of yarn and fabrics which admittedly exist, together with other defects whose existence is not even recognised, were formerly due to faults in the machinery employed. Many of these have been eliminated in the course of time; and the physicist is now concerned rather with studying the causation of defects which are inherent in the properties of the raw material"

This warrants a note of criticism. The present writer pointed out that though the importance of physical tests on raw materials cannot perhaps be overstated, at any rate from the grower's point of view, yet at the same time it should be clearly understood that there are, on the industrial side, limitations to the profitableness of such work. I refer particularly to trade samples of raw material. It would no doubt be an easy though laborious matter to obtain valuable information concerning certain characteristics of the cotton fibres and their correlations, for example, provided one confines the effort to one or more special varieties. But it must be borne in mind that the practical spinner has no direct interest in special varieties, he buys and mixes his raw material according to market prices Such raw material makes physical research on the "textile unit" a most uncertain and despondent field when the results are interpreted according to the expectations of the spinner or manufacturer. To take an example, it is now known that the lustre of a doubled yarn depends on a certain relationship between the constants for spinning the singles and for doubling them If this condition is not satisfied, it is easy to make a highly lustrous raw cotton into a less lustrous yarn than might have been produced by using a less lustrous cotton and working it properly. This is quite apart from the measurable characteristics of raw cottons, such as staple length, fineness, or convolutions, etc., and shows that the relative *position* of the fibres, determined by the spinning processes, is at least as important as the properties of isolated fibres Again, the percentage irregularities of yarns spun from high- and low-grade cottons are about the same, so that this important property does not depend appreciably on the raw material. Such examples might be multiplied a hundred-fold. While not denying that many of the defects existent in yarns and fabrics are rightly concerned with variability in the raw material, it is necessary to emphasise the fact that many defects are traceable to the machines, scarcely one of which, in the writer's opinion, cannot be improved by physical research. Dr. Balls' remark that "the utility of the scientist in industry is largely conditioned by the degree of stability of the industry" is only too true; it enforces the necessity for work on the complex mixtures of raw material almost universally used in practice, and leads us to the conclusion that work of this character is the more immediate. Furthermore, it is the duty of the Textile Industrial Research Associations to supply such practical information while still keeping a preserve for work on "textile units," which, it is hoped, will eventually be of vital importance to the producer of the raw material.

Dr S. A. Shorter dealt with the nature of the recovery from strain of the wool fibre, in particular, attributing the creep to the combined effects of elastic and impeded elastic portions of the fibre structure rather than to its plasticity, to which property other authors have ascribed the effects. He stated that the elasticity of wool approaches the ideal, the hysteresis being almost entirely a true effect, and suggested that the fibre acts as a two-phase system, including (*a*) a perfectly elastic framework, (*b*) a viscous fluid; the two affording a complete explanation of the phenomena observed in the finishing of woollen and worsted fabrics. Mechanical models were described to illustrate the type of structure advocated, and the system of impeded elastic elements was used to explain how the shedding fault arises in a loom which has been standing over (say) the week-end.

Some experiments on loaded gelatin sticks were described by Mr. Pool, who concluded that the elastic effects observed in such purely colloidal systems were analogous to those simulated by Shorter's model It was pointed out by Dr. Mardles that similar effects were common in many materials, *e g* steels, time and stress introducing new phases initiated by molecular changes. Mr. Peirce thought the effects were due to impeded but reversible orientations within the mass and these effects were ultimately inherent in the molecules themselves. In his paper on the fibre balance, Dr. Barratt described load-extension diagrams showing the relative degree of non-recovery from strain in wool, cotton, silk (viscose) and flax, the order, as indicated, being decreasing. Dr. Shorter was of the opinion that in the case of the wool fibre, practically all the residual strain would disappear by wetting, while he agreed that with cotton fibres a small amount of non-recovery persists.

Two important communications were made by Dr T. Barratt on the lustre of cotton fibres and the transparency of fabrics. The lustre comparisons were made by a special arrangement of a Joly photometer, the fibre pads being so mounted that varying angles of incidence and diffusion could be obtained, and also so that they could be rotated in their own plane. Unmercerised and mercerised cotton and glass fibres were tested and the conclusions drawn that (1) the light reflected from a mercerised fibre in certain positions is concentrated within a small angle; (2) the light from an unmercerised (twisted) fibre is scattered over a wide angle; and (3) the lustre is enhanced when a number of mercerised fibres are laid parallel to each other (the case of a sateen with "floating" threads) The increased lustre shown by a mercerised fibre is due to light regularly reflected in a plane containing the length of the fibre In keeping with this result, the work of the writer and Mr Adderley was mentioned, which showed that in doubled yarns the optimum lustre was obtained when the fibres in the doubled yarn are parallel to its axis, so that, looking

along the yarn, the light is mainly reflected along the length of the fibres.

Using the Joly photometer, measurements of (1) the total transparency of fabrics (defined as percentage of incident light transmitted), (2) thread transparency (the percentage of light falling on the threads alone, which is transmitted), were made. The determination (2) was made possible by dyeing the threads black and so obtaining a measure of the light transmitted by the spaces alone. From the combined readings it is then possible to calculate the total light incident on threads *alone* and that transmitted by threads *alone*, which is a measure of thread transparency.

Mr. C. R. Nodder showed slides of the structural characteristics of compressed flax fibres, up to fifty daily growth rings being visible, and also the spiral fibrillæ in each layer. Herzog and Jancke have obtained X-ray point diagrams with flax and ramie fibres which they attribute to a rhombic (or monoclinic) symmetry of constituent crystallites. With powdered fibres they obtained diffraction rings confirming this result. Flax and ramie fibres subjected to similar compression presented optical effects which indicate the true crystalline nature of their structure.

A large number of physical data relating to the silk fibre (the ultimate filament of fibroin, two of which, gummed together by sericin, form the cocoon thread) were detailed by Dr. W. S. Denham. The most interesting of these concern the crystalline structure found by Herzog and Jancke. Some measurements on the lustre of silk fibres with the plane of incidence perpendicular and parallel to the fibre length were discussed in terms of the arbitrary expressions for lustre recommended by Zart, Schultz, and Adderley, and Dr. Denham reasonably advocated some universal standard. The lustre is greater with the plane of incidence containing the fibre length (cf. Barratt, *supra*). The thermal conductivities of textiles have been measured by Miss Rood; the values, for the same density, increasing in the order, silk, wool, artificial silk, linen, and cotton.

An interesting account of experiments on the tautness of aero-fabrics was given by Dr. Ramsbottom, who pointed out that though dope may be regarded as the primary factor in fixing tautness, still the nature of the fabric is of importance in maintaining this property at high humidities and after long exposure. Fabrics woven from fine yarns preserve tautness better than those containing coarser yarns, and linen, cotton, and silk all give satisfactory tautness at low humidities. With cotton and linen, at high humidities the tautness falls but recovers with absorption of water by the fabric, whereas with silk the tautness falls off continuously, so that silk fabrics are inferior to others. Mercerised cotton is preferable to unmercerised cotton or linen. Measurements on strength and deterioration on weathering were given. Dr. de Waele asked if it were possible to obtain a mesh of (say) silk and cotton which would have constant tautness, in reply to which Mr. Crompton said it was quite feasible to double artificial silk and cotton to test this point.

The action of light on textiles was discussed by Dr. Barr, who laid stress on the difficulties of measuring the photochemical action due to sunlight, which is the real aim of such research. With sunlight the spectrographic method has given negative results, while only incomplete data have been obtained by using glass screens. The method of first dyeing the fibres and exposing them to white light has given some practical results, but these are difficult to interpret, being complicated by the ill-defined nature of the light stimulating the reaction and the possibility of unknown interaction between fibre, dye, and the reaction products.

With the mercury arc in quartz, rapid deterioration of textile fibres may be developed, but such effects cannot be safely translated into terms of sunlight. Cellulose is very sensitive to wave-lengths less than 3000 Å U., which exist in the mercury arc but not in sunlight. Aston's work on cotton and linen threads (for aero-fabrics) indicates that with light from the mercury arc, the most destructive rays have wave-lengths less than 3990 Å.U., a conclusion which has been verified by Ramsbottom by using coloured glass screens. Two hundred hours' exposure to sunlight produced no effect. Assuming that ionised oxygen is responsible for the deterioration, Lindemann has deduced from the quantum theory that the most destructive radiation has a wave-length of 3230 Å.U.

Very little is known about the tendering action of light on other textile fibres. Silk appears to be considerably more affected than linen, while wool is almost immune.

Mr. F. D. Farrow referred to some recent advances in the experimental study of warp sizing, and dealt with the work of Owen and New on the oscillating resisting properties of yarns, and that of Farrow and Lowe on the viscosity of starch pastes. The work on viscosity involves a modified Poiseuille's equation, a "coefficient of flow" being measured which is proportional to a power of the pressure, the index varying between 1 and 2.

A review of the recent work on the moisture relations of textile materials was contributed by Mr. A. R. Urquhart and Dr. A. M. Williams. The hysteresis effects observed in the authors' work have been interpreted in terms of Zsigmondy's theory of the existence of capillary spaces within a gel, which, in the case of cotton, have a diameter of the order 13×10^{-8} cm. A study of the rates of absorption and desorption indicates that these processes are discontinuous.

A paper on the effect of water in the wet-spinning of flax was given by Dr. W. H. Gibson, who held the view that the process was conditioned by a gradual variation in the fibre constitution from pectin through intermediate products to cellulose. There is apparently a considerable breakage of the fibres (about 12 in. long) with a drafting reach of 3¼ in., as might be expected, and frequency curves showing the displacement of the breaking load modes of the yarn and rove confirm this.

In addition to the papers submitted for discussion, a number of interesting slides of linen fabrics from Tutankhamen's tomb were exhibited by Dr. A. Scott. These depicted (*a*) a linen veil, unbleached, 150-160 threads per inch × 80 threads per inch, in reflected and transmitted light; (*b*) a pall of much coarser linen fabric; and (*c*) a very friable linen fabric having two threads one way and one the other.

Sir Robert Robertson pointed out the great importance of obtaining further knowledge of the action of light on fabrics, and Mr. Lester remarked that we knew next to nothing about the life of a fabric, recalling the process of laundering and the effect of acid. In a few months a fabric might lose 60 per cent. of its strength.

A. E. OXLEY.

University and Educational Intelligence.

BIRMINGHAM.—The degree of Ph.D. has been awarded to the following candidates, the subjects of the theses being indicated in each case: Mr. N. F. Budgen (Researches with cadmium); Mr. Denis Bunting (An investigation of the brittle ranges of brass); Mr. Kamil Iskander (The development of precision measuring instruments for the determination of the heating value of gases); Mr. T. D. Jones

(The strata temperatures of the South Wales coal field, and causes of variation in the same, Hygrometric observations in South Wales collieries).

DUBLIN —Among the honorary degrees which have been conferred at Trinity College are the following: *D.Sc.*: Prof. R. A. Millikan, of the California Institute of Technology, Pasadena, and Prof. E. B Poulton, Hope professor of zoology in the University of Oxford; *D.Litt.*: Prof. Ernest A. Gardner, Yates professor of archæology, University College, London.

LEEDS.—Mr. A. Seymour-Jones has presented to the Leather Industries Department his library, consisting of about 200 books on leather and kindred subjects, and a set of framed photomicrographs for display in the Department.

It has been decided to institute a lectureship in medical radiology and electro-therapeutics, and to appoint thereto Dr Scargill and Dr. Cooper as joint lecturers. Mr. William Davies has been appointed demonstrator in engineering.

LONDON.—Prof E. A. Gardner, Yates professor of archæology in the University, tenable at University College, has been elected Vice-Chancellor for 1924–25 in succession to Mr. H. J. Waring

Dr. B B. Baker has been appointed as from October 1 to the University chair of mathematics, tenable at the Royal Holloway College. Since 1920 Dr. Baker has been lecturer in mathematics at the University of Edinburgh, in 1921 he was elected a fellow of the Royal Society of Edinburgh and hon. secretary of the Edinburgh Mathematical Society. His published work includes various articles in mathematical and scientific journals.

Dr. C. L. Burt has been appointed as from August 1 to the University (part-time) chair of education, tenable at the London Day Training College. From 1908 to 1912 Dr. Burt was lecturer in experimental psychology in the University of Liverpool, and from 1912 to 1913 assistant lecturer in the Psychological Laboratory, Cambridge. Since 1913 he has been psychologist in the Education Department of the London County Council. He has published a number of works on intelligence tests and allied subjects.

The title of professor of surgery in the University has been conferred on Dr. C. C. Choyce in respect of his appointment as Director of the Surgical Unit at University College Hospital Medical School.

The title of reader in geology in the University has been conferred on Mr. H Gladstone Smith in respect of the post held by him at East London College. Mr. Smith has been lecturer in geology at East London College since 1918.

The title of professor of physics in the University has been conferred on Prof. O. W. Richardson in respect of his part-time appointment as Director of Research in the Department of Physics at King's College. Prof. Richardson will cease to hold the Wheatstone chair of physics, which he has occupied since 1914, on taking up the Yarrow Research Professorship of the Royal Society on August 1.

Sir Hermann Gollancz has given his library to University College to commemorate his twenty-one years' tenure of the Goldsmid professorship of Hebrew. Mrs. Preedy has presented to the University library a valuable collection of books on Greek and Roman archæology and art, formerly belonging to her son, the late J. B. Knowlton Preedy, who served for some years prior to the War as a secretary in the University Extension Department.

The following doctorates have been conferred:—D.Sc. (*Chemistry*): Miss M. L. V. Gayler (Bedford College), for thesis entitled "The Constitution and Age-hardening of the Quaternary Alloys of Aluminium, Copper, Magnesium, and Magnesium Silicide"; D.Sc. (*Physiology*): Mr. J. A. Hewitt (King's College), for a thesis entitled "Metabolism of Carbohydrates (Part III.)"; D.Sc (*Physiology*): Mr. F. M. R. Walshe (University College and University College Hospital Medical School), for a thesis entitled "(i.) The Physiological Significance of the Reflex Phenomena in Spastic Paralysis of the Lower Limbs, (ii) On certain Tonic or Postural Reflexes in Man, with special reference to the so-called 'Associated Movements,' (iii.) On Variations in the form of Reflex Movements, notably the Babinski plantar response, under different degrees of Spasticity and under the influence of Magnus and de Kleijn's Tonic Neck Reflex"; D.Sc. (*Geology*): Mr. Ernest Neaverson, for a thesis entitled "Ammonites from the Upper Kimmeridge Clay."

A degree of M Sc. in the principles, history, and method of science has been instituted for both internal and external students.

MANCHESTER.—Applications are invited for the headship of the department of pure and applied physics in the College of Technology. The position carries with it the title and status of lecturer in the University. The latest date for the receipt of applications, which should be sent to the Registrar of the College, is July 16.

OXFORD.—Among the recipients of honorary degrees at the Encænia held on June 25 were Sir Humphry Rolleston, Bart., president of the Royal College of Physicians, and Prof. S. Alexander, professor of philosophy in the University of Manchester, who received the degrees of D.Sc. and D Litt. respectively.

PROF. SYDNEY CHAPMAN, at present professor of mathematics and natural philosophy in the University of Manchester, has accepted the invitation of the Governing Body of the Imperial College of Science and Technology to undertake the chief professorship of mathematics at the Imperial College beginning in September next, in succession to Prof. A. N Whitehead, who has been appointed to the chair of philosophy at Harvard University, U.S.A.

AT the universities' conference held at Simla in May it was decided that an Indian inter-university board should be constituted with one representative of each university, to facilitate the co-ordination of university work, to assist in obtaining recognition in other countries of Indian degrees, diplomas, and examinations, to act as an appointments bureau for Indian universities, to facilitate the exchange of professors, and generally to fulfil such duties as may be assigned to it from time to time by the Indian universities. The cost of maintenance of the board is to be met by equal contributions from the universities, but the Government of India and the provincial governments are to be asked to make a grant towards its expense. It has for some years been recognised that some such co-ordinating body was needed, and in April 1920 a committee was formed for drafting an outline of its functions and constitution. The project was further advanced at the Congress of Universities of the Empire in 1921, but the universities were not unanimously in favour of the proposals then formulated. The board now to be set up will be the Indian counterpart of the Conference of Canadian Universities, the Standing Advisory Committee of the Australian Universities, the Vice-Chancellors' Committee of South Africa, and the Standing Committee of Vice-Chancellors and Principals of the Universities of Great Britain and Ireland.

Early Science at the Royal Society.

June 29, 1681. In discussion the president [Wren] observed, that it was necessary, that all wholesome food should have oils: that most roots wanting oil are not of themselves a good nourishment: and that in Ireland, where the people feed much on potatoes, they help themselves by drinking milk soured, to make the potatoes digest the better.

June 30, 1686. Ordered, that the treasurer, to encourage the measuring of a degree of the earth, do give to Mr. Halley fifty pounds or fifty copies of the "History of Fishes," when he shall have measured a degree to the satisfaction of Sir Christopher Wren, the president, and Sir John Hoskyns.

July 1, 1663. Mons. Moncony's description of the way used in Egypt of hatching in ovens, was read, and ordered to be registered. He was of opinion, that the temperament of the air in Egypt contributed greatly to the method of hatching chickens, since the grand duke having sent for some of the christians of Cairo, who are the only persons, that carry on that business, they had built an oven at Florence, but failed of hatching chickens.

1680. Sir Christopher Wren affirmed, that extreme freezing will sweeten salt water: that the curd which is then upon the surface of the water, will be found sweet: that this is found in Hudson's Bay: and that a little hole left in a window in winter, and a little fire in the chimney, will freeze anything to a great degree.

July 2, 1662. It was ordered that the committee appointed to view the Towgood's engine, meet the Saturday following afternoon in the Temple church.—A new astronomical hypothesis of a stranger was referred to the consideration of Dr. Wren [and others].

1668. The experiments appointed for this meeting not being prepared by reason of the operator's indisposition, it was ordered that on the like occasion another person should be hired and made use of *pro tempore* to do the manual part, that the Society might not be destitute of experiments.

July 3, 1661. Mr. Croune to procure, against the next meeting, some fresh vipers; and the operator to provide fresh hazel-sticks.—Mr. Evelyn presented his relation of graving and etching; and, after public thanks returned to him, was requested to transcribe it.

1672. Dr. Grew was put in mind to see, what might be discovered of the peristaltic motion in plants, asserted by Signor Malpighi.—Mr. Hooke was called upon for making a report concerning Signor Cassini's paper concerning the satellites of Jupiter, and desired to give in writing what he had said upon it that it might be without mistake imparted to Signor Cassini, who had desired that favour

1679. It was ordered that Mons Papin be employed for the writing of all such letters, as shall be ordered, to the correspondents of the Society: and that for so doing the said Mons. Papin shall receive the sum of eighteen pence per letter, unless the letter shall exceed two sides of a quarter of a sheet of paper; for every of which he shall receive two shillings.

July 4, 1678. A letter was read to the meeting written by Jacobus Pighius, dated at Padua, wherein he expressed the high respect which he had for the Society, and his great desire of being known to them. He mentioned his esteem for the English in general, and the favour done him by the English students at Padua, in choosing him their pro-syndic.

1683. It being thought proper, that some man should be appointed to keep the door of the meeting-room during the time that the Society was assembled, the porter, who removed the seats, was ordered to wait, and to have 12*d*. a time, when he waited.

Societies and Academies.

LONDON

Royal Society, June 19.—J C. **McLennan** and G M. **Shrum**: On the luminescence of nitrogen, argon and other condensed gases at very low temperatures Experiments are described on the luminescence of nitrogen and argon at the temperature of liquid hydrogen under electronic irradiation. The spectra of the light emitted by both elements contains wavelengths close to but not coincident with that corresponding to the auroral green line. Both solid nitrogen and solid argon phosphoresced brilliantly under electronic excitation. From these experiments there is no confirmation of Vegard's theory that the auroral green line originates in vaporous solidified nitrogen — H. Grayson **Smith**: On the fine structure of the band spectra of sodium, potassium and sodium-potassium vapours. Four bands of the blue-green group of the band absorption spectrum of sodium and three bands of the red group of the band spectrum of potassium have been examined. Two values of the moment of inertia of the normal sodium molecule have been found from different bands, $2 \cdot 515$ and $2 \cdot 286 \times 10^{-39}$ gm.cm.^{2}. Assuming that the molecule is diatomic, the corresponding values for the distance between the nuclei are $1 \cdot 151$ and $1 \cdot 098 \times 10^{-8}$ cm. The moment of inertia of the potassium molecule is $18 \cdot 39 \times 10^{-39}$ gm cm.^{2}, so that the distance between the nuclei of a diatomic molecule is $3 \cdot 069 \times 10^{-8}$ cm., which is in fair agreement with X-ray measurements. Two bands of a new group found by Barratt in the absorption spectrum of a mixture of sodium and potassium vapours give a moment of inertia of $6 \cdot 615 \times 10^{-39}$ gm.cm ^{2}. This agrees with the supposition that these bands are due to NaK molecules, the distance between the nuclei being $2 \cdot 137 \times 10^{-8}$ cm.—Lord **Rayleigh**: (1) The non-luminous oxidation of phosphorus in an oxygen atmosphere. The views on phosphorescent combustion of phosphorus developed in former papers require that phosphorus vapour, when apparently inactive in an atmosphere of oxygen, should in reality be combining with it at isolated centres, though the action fails to spread. Either this action or the ordinary phosphorescent combustion can be caused to occur *at one given pressure and external temperature*. The rate of oxygen absorption is widely different in the two cases. With a given area of phosphorus surface, the rate of action is enormously increased by allowing a large oxygen space around it. The action occurs in the volume of the gas space, and therefore between oxygen and phosphorus vapour (2) The light of the night sky: its intensity variations when analysed by colour filters. The comparison light is a uranium salt rendered self-luminous by radioactivity. Three alternative colour filters are provided; one of these approximately isolates the green aurora line A red and a blue filter isolate the regions of the spectrum on either side of this line, excluding the line itself. The light of the sky as seen through these is equalised with the standard by means of neutral tinted glasses. Owing to faintness of the light, colour differences are not perceptible. Systematic observations of the auroral light for fifteen months, and of the other components for seven months, show variations which are far too large to be explained by changes in atmospheric transparency. The highest values of the auroral light were found during October 1923, which was the middle of a period of three months showing considerable sunspot activity For the rest of the time there were few spots. The auroral light varies very little over the whole range of latitude from England to the Cape of Good

Hope. The polar aurora is contrasted with this non-polar aurora. The latter may be a phenomenon of phosphorescence, the luminosity being excited by the sun during daytime and carried round by the earth's rotation as in the phosphoroscope. The light of the night sky is much richer in red, measured relative to blue, than is daylight. In this respect it approximates to the light of a ½-watt incandescent lamp.—W. G. **Palmer** and F. H. **Constable**: The catalytic action of copper. Pt. IV. By measuring the velocity of dehydrogenation of alcohol passing over copper film catalysts when the temperature of the catalyst is rising and again when it is falling, a measure of the temperature coefficient of the change is obtained Above a temperature of 280° C the adsorbed alcohol film becomes unimolecular, and the aldehyde bombarding the bare copper surface polymerises and causes decay of the activity by covering the surface. No evidence of decay due to sintering was obtained during the experiments, which lasted up to five hours. The catalytic activity varied with the temperature of reduction of the copper oxide in a periodic manner; in general the greater the activity of the catalyst the less the temperature coefficient. Reduction at 420° C. seems to change both the grain structure and the nature of the surface. The "heat of activation" of an alcohol molecule is held to vary with the arrangement of the atoms in the surface on which it is adsorbed—Rev. A. L. **Cortie**: The 27-day period (interval) in terrestrial magnetic disturbance. At a period approaching minimum solar activity (May 1921–July 1923), the persistence of notable magnetic disturbances in series at a 27-day interval, when the sun was entirely free from spots, and even sometimes of bright faculæ and flocculi, led to two long sequences of such disturbances, May 12, 1921–April 13, 1923, containing 26 synodic recurrences, and October 27, 1921–July 10, 1923, embracing 23 recurrences. In each sequence, from the magnetic data alone, a mean solar latitude has been computed, and a mean solar longitude, which fit accurately two regions of intermittent solar activity, one in the sun's northern hemisphere, and the other in the southern hemisphere. Moreover, these two regions, separated by about 180°, practically contained all the sunspots that had appeared in the period discussed. But there is no parity between the intensity of sunspot or floccular activity, and of magnetic disturbance. In the period discussed, magnetic disturbances occurred without, but not independently of, solar activity in a restricted area.—E. K. **Rideal** and C. G. L. **Wolf**. The destruction of rennin by agitation: a case of catalysis at an air-liquid interface. Rennin solutions undergo a chemical destruction when agitated, due to a chemical reaction occurring at the air liquid interface. The second reactant is a capillary active substance which is present in ordinary rennin solutions, but can be removed by dialysis. The dialysable reactive constituent is probably a fatty acid.—W. G. **Palmer**: The use of the coherer to investigate adsorption films. Loose contacts or "coherers" formed of tungsten-tungsten, carbon-tungsten, and platinum-platinum surfaces have been studied with particular regard to the action of the gas surrounding them. The voltage required across the contact to effect full metallic conduction is, for a given gas, a constant practically independent of the pressure of the gas and varying between wide limits for different gases. The cohering action may be due to the evaporation of an adsorbed film of gas under electrical stress From the critical voltage the latent heat of evaporation of the film is calculated.—R. J. **Lang**: On the ultraviolet spark spectra of some of the elements. The wavelengths are given for the following elements: carbon, calcium, titanium, vanadium, chromium, manganese, cobalt, arsenic, molybdenum, cadmium, tin, antimony, tellurium, cerium, platinum, gold, thallium, lead, bismuth, uranium, in the ultraviolet region. They range from $\lambda = 2000$ A to $\lambda = 224$ A.—W. T. **Astbury** and Kathleen **Yardley**: Tabulated data for the examination of the 230 space-groups by homogeneous X-rays. Diagrams are given, one for each of the 230 space-groups, showing the distribution of symmetry elements and the relative positions and orientations of the molecules in the unit cell, and accompanying these diagrams are tables giving the fundamental Bravais lattice, the number of asymmetric molecules per cell, the abnormal spacings to be expected, and the possible molecular symmetry for each space-group—J. W. **Campbell**: On the drift of spinning projectiles. The following assumptions are made: (1) The shell is stable. (2) Its initial rotation is all about the axis of symmetry. (3) The resistance of the air can be represented by two forces, one along the axis of symmetry of the shell, and the other at right angles to the axis and in the plane of the tangent to the trajectory and the axis, the latter force acting at some point (variable) in front of the centre of gravity of the shell. When the initial oscillations have been damped out by air resistance, (2) is practically realised. Experiments show that the principal parts of the air resistance are represented by the force system (3). The solution obtained contains. (1) A formula for lateral drift. (2) Formulæ for the vertical and lateral components of the yaw. (3) A formula for cross-range wind deflexion. The solution is valid provided the yaw and the inclination of the axis of the shell to the plane of fire do not become too great, and it exhibits the well-known properties of the phenomena of drift—A. L **Narayan** and D. **Gunnaiya**: Absorption of lithium vapour. Absorption of the lithium vapour in the visible region has been studied. The vapour possesses channelled absorption spectrum both on the short and the long wavelength side of the first member of the principal series.

PARIS.

Academy of Sciences, June 10.—M. Guillaume Bigourdan in the chair.—A. **Haller**: The action of tetrachlorophthalic and tetrabromophthalic acids on turpentines. A new method of preparation of the camphols and therefore of the lævo- and dextro-camphors. The interaction of the tetrahalogenophthalic acids and pinenes gives bornyl, isobornyl and fenchyl tetrahalogenophthates, which by saponification give mixtures of these alcohols and their acid esters The alcohols thus formed give fenones or camphors according to the terpene employed.—Charles **Rabut**: The scientific rules to be followed in structures of armoured concrete.—M. de **Sparre**: Pelton turbines working under a variable head.—J. Kampé de **Fériet**: A particular class of hypergeometrical functions of one variable.—Georges J. **Rémoundos**: The pairs of meromorp or algebroid functions corresponding to the points of an algebraic curve—Octave **Mayer**.—A geometrical interpretation of the second fundamental quadratic form of a surface; in relation with the theory of parallelism of Levi-Cività.—P. **Dumanois**: The use of light alloys for the pistons of internal combustion motors.—A. **Barbaud**: Tracing lines of height and its application to aerial navigation over the sea.—T **Peczalski** and A. **Launert**: The electrical resistance and density of copper cemented by salts.—P. **Bovis**: The absorption spectrum of bromine. The maximum absorption corresponds sensibly to the same wavelength for liquid bromine as for its vapour; but, calculated to the same weight of bromine, the maximum values are

different, the optical density of the liquid being more than double that of the vapour.—M. **Duffieux**: The origin of the first and second positive group of the band spectrum of nitrogen.—H. **Chipart**: The electromagnetic theory of optical activity and the postulate of MacCullagh.—H. **Pélabon**: The direct formation of the oxychlorides, oxybromides, and oxyiodides of mercury. Mercuric chloride, bromide, and iodide can unite directly with yellow or red mercuric oxide, dry or in the presence of water. In the last case the equilibrium is affected by alkali dissolved from the glass containing-vessel.—Stefan **Triandafil**: The influence of temperature on the galvanic polarisation of nickel.—René **Dubrissay**: The capillary phenomena which appear at the surface of separation of water and benzene in the presence of the fatty acids and of alkalies.—Francis **Perrin**: The law of decrease of the fluorescent power as a function of the concentration.—E. **Darmois**: The compounds of malic acid and copper. Measurements of the P_H and rotations of solutions of copper hydroxide in malic acid indicated the presence of two malates only, the acid salt and Liebig's basic salt.—M. **Bourguel**: The transformation of the substituted acetylene hydrocarbons into true hydrocarbons by sodium amide. Hydrocarbons of the type $RC{\equiv}C.CH_3$ are readily transformed by heating with sodium amide at 110° C. into hydrocarbons of the type $(CH_3)R.C{\equiv}CH$. The homologues $RC{\equiv}C.C_2H_5$ undergo a similar change, but much more slowly.—A. J. A. **Guillaumin**. The action of hydroxylamine on ethyl tartrate.—Alphonse **Mailhe**: The decomposition of chlorophyll extracts. Distilled with magnesium or zinc chloride, these extracts give a gas rich in carbon dioxide, a mixture of liquid hydrocarbons containing a high proportion of olefines, and a solid, probably dinonyl-ketone $(C_9H_{19})_2CO$.—P. **Lasareff**: The mass of metallic iron contained in the ferruginous deposits at Koursk (Central Russia).—Albert **Nodon**: Observations on the propagation of the explosive waves resulting from the experiments at La Courtine. Details of the methods employed to measure the velocities of the air waves and earth waves caused by the explosions at La Courtine, distance 243 kilometres.—P. **Gillot**: Remarks on the determinism of sex in *Mercurialis annua*. This plant is unsuitable for investigations on sexual determinism.—A. **Maige**: The different stages of amylogenic condensation.—D. **Chouchack**: Influence of the nutritive elements on the development of soil bacteria.—F. **Granel**: The pseudobranchia of the selacians.—MM. **Barthélemy** and **Bonnet**: The influence of the temperature on the utilisation of energy in the course of the development of the egg of *Rana fusca*.—MM. J. E. **Abelous**, **Moog**, and **Soula**: Splenectomy and the demineralisation of the organism.—P. **Le Noir** and A. **Mathieu de Fossey**. Study of the ionic urinary acidity in normal man. The influence of food.—MM. **Pézard**, **Sand**, and **Caridroit**: Hormono-sexual modifications in adult Gallinaceae and the theory of specific form.

Official Publications Received.

Annales de l'Institut de Physique du Globe de l'Université de Paris et du Bureau Central de Magnétisme terrestre. Publiées par les soins de Prof. Ch. Maurain. Tome 2. Pp. viii+150. (Paris: Les Presses universitaires de France.)

Department of Agriculture and Natural Resources: Weather Bureau. Annual Report of the Weather Bureau for the Year 1920. Part 4: Hourly Results of Observations made at the Magnetic Observatory of Antipolo near Manila, P.I., during the Calendar Year 1920. Pp. 47. (Manila: Bureau of Printing.)

Department of Commerce: Bureau of Standards. Scientific Papers of the Bureau of Standards, No. 486: Some new Thermoelectrical and Actinoelectrical Properties of Molybdenite. By W. W. Coblentz. Pp. 375-418. (Washington: Government Printing Office.) 10 cents.

Annual Conference of the Universities of Great Britain and Ireland, 1924. Report of Proceedings. Pp. 63. (London: Universities Bureau of the British Empire.) 1s.

Diary of Societies.

SATURDAY, JULY 5.

INSTITUTION OF MECHANICAL ENGINEERS (Joint Meeting with the Institution of Civil Engineers), at 11.30.—Draft Standard Test Code for Hydraulic Power Plants, drawn up by a Joint Committee of the Institutions of Civil and Mechanical Engineers.

RONTGEN SOCIETY AND THE ELECTRO-THERAPEUTICS SECTION OF THE ROYAL SOCIETY OF MEDICINE (Joint Meeting at the Radcliffe Infirmary, Oxford), at 3.30.—Sir Thomas Horder: The Influence of Radiology upon the Criteria of Disease (Mackenzie Davidson Memorial Lecture).—Prof. S. Russ: Experimental Studies upon the Lethal Dose of X-rays and Radium for Animal Tumours.

MONDAY, JULY 7.

INSTITUTION OF SANITARY ENGINEERS (at Royal United Service Institution), at 10 A.M. and 2.—International Conference.

PHOTOGRAPHIC CONVENTION (at Royal Photographic Society of Great Britain), in afternoon.—Presidential Address.—Annual General Meeting.

FARADAY SOCIETY (at Chemical Society), at 7.45.—Annual General Meeting.—At 8.—G. R. D. Hogg: Note on the Conduction of Heat down the Necks of Metal Vacuum Vessels containing Liquid Oxygen.—C. L. Haddon: The Mechanism of Setting of Calcium Sulphate Cements.—J. J. Doolan and Prof. J. R. Partington: The Vapour Pressure of Tellurium.—E. E. Turner and W. H. Patterson: Cryoscopy in Sodium Sulphate Decahydrate.—D. B. McLeod: The Viscosity of Binary Mixtures.—J. B. Firth and F. S. Watson: The Catalytic Decomposition of Hydrogen Peroxide Solution by Animal Charcoal—The Production of Highly Active Charcoals.—Prof. A. J. Allmand and A. N. Campbell: The Electrodeposition of Manganese.—J. Grant: Concentration-Cells in Methyl Alcohol. Part II. Solutions containing Tetraethyl Ammonium Iodide.—F. H. Jeffery: The Electrolysis of Solutions of Potassium Oxalite with a Tin Anode and an Electrometric Determination of the Constitution of the Complex Anions formed.—F. J. Fraser: An Improved Form of Crook's Elutriator.

THE ARISTOTELIAN SOCIETY (at University of London Club), at 8.—Prof. H. Wildon Carr: The Scientific Approach to Philosophy.

TUESDAY, JULY 8.

INSTITUTION OF SANITARY ENGINEERS (at Royal United Service Institution), at 10 A.M. and 2.—International Conference.

INSTITUTION OF CIVIL ENGINEERS, at 8.30.—Prof. Elihu Thomson: Electrical Progress and its Unsolved Problems (James Forrest Lecture).

WEDNESDAY, JULY 9.

INSTITUTION OF SANITARY ENGINEERS (at Royal United Service Institution), at 10 A.M. and 2.—International Conference.

DECIMAL ASSOCIATION (Decimal-Metric Conference) (at Institution of Electrical Engineers), at 11, 2.30, and 4.30.—Discussion on Decimal Coinage—Ancient and Modern Weighing Appliances and other Appliances (Lecture)—Discussion on Metric System.

ROYAL SOCIETY OF MEDICINE (Sub-section of Proctology (Section of Surgery): Annual Clinical Meeting in conjunction with the American Proctologic Society), at 11.—Dr. Jackson: Quo Vadis?—Dr. Beach: The Evolution of Proctology.—At 5.30.—Graeme Anderson and others: Discussion on The Injection Treatment of Hæmorrhoids.

RADIO SOCIETY OF GREAT BRITAIN (Informal Meeting) (at Institution of Electrical Engineers), at 6.—P. R. Coursey: The Manufacture of Condensors.

THURSDAY, JULY 10.

INSTITUTION OF SANITARY ENGINEERS (at Royal United Service Institution), at 10 A.M. and 2.—International Conference.

INSTITUTION OF ELECTRICAL ENGINEERS (Kelvin Centenary), at 12.30.—Dr. A. Russell: Address.

INSTITUTION OF CIVIL ENGINEERS (Kelvin Centenary), at 4.30.—Sir J. J. Thomson: Kelvin Centenary Oration.—Presentation of the Kelvin Medal, 1923, to Prof. Elihu Thomson.

ROYAL SOCIETY OF MEDICINE (Sub-section of Proctology (Section of Surgery): Annual Clinical Meeting in conjunction with the American Proctologic Society), at 4.30.—Dr. Montague and others: Discussion on The Treatment of Pruritus Ani.—Dr. Hirschman and others: Discussion on The Treatment of Rectal Prolapse.

FRIDAY, JULY 11.

ROYAL SOCIETY OF MEDICINE (Sub-section of Proctology (Section of Surgery): Annual Clinical Meeting in conjunction with the American Proctologic Society), at 4.30.—W. E. Miles and Mr. Lockhart-Mummery: Discussion on The Treatment of Cancer of the Rectum.

Editorial and Publishing Offices:
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C. 2.

Editorial communications should be addressed to the Editor.
Advertisements and business letters to the Publishers

Telephone Number: GERRARD 8830.
Telegraphic Address: PHUSIS, WESTRAND, LONDON

Supplement to NATURE

No. 2853 JULY 5, 1924

Insulin.[1]

By Prof. HUGH MACLEAN, Professor of Medicine, University of London.

NO recent discovery in medical science has created so much interest, both in lay and in professional circles, as the advent of insulin. The great importance of this discovery lies in the fact that through its agency a fresh outlook and a new hope have been opened up to the unfortunate sufferer from diabetes—an outlook in which despair and the prospect of almost certain death have given place to health and hope. From the humanitarian point of view, this itself is no mean achievement, but insulin has many interesting features besides its success in therapeutics, and the problem of its method of action presents an intellectual puzzle, which, from its complexity and obscurity, bids fair to engage our ablest scientific minds for many years to come.

Before discussing the results obtained from the use of insulin in diabetes, it is essential that certain points bearing on the metabolism of our foodstuffs should be clearly understood, for diabetes is nothing more than an interference with the normal mechanism which burns up our food in the body. Unlike the healthy individual, the diabetic subject cannot utilise his food, and, in consequence, becomes thin and ill. He presents the curious anomaly that the more food he eats the thinner and weaker he becomes, for, as the result of the perverse process of metabolism from which he suffers, much of the food that he is unable to use is changed into poisonous bodies which circulate in the blood, and cause destruction of body tissue, soon to be followed by death.

Though one of the most important symptoms of diabetes is glycosuria, or the presence of sugar in the urine, it is important to appreciate the fact that diabetes is a disease not of sugar or carbohydrate metabolism alone, but that the metabolism of all our foodstuffs is involved.

METABOLISM OF FOODSTUFFS IN THE BODY.

Our knowledge of the various changes which the different foodstuffs undergo in the body is unfortunately very meagre, but we know sufficient to enable us to understand the main points in diabetes. Our food consists largely of starchy material or carbohydrate, with a certain amount of fat, and a fair proportion of such products as meat, fish, eggs, and other related bodies known as proteins.

Fats and carbohydrates are used simply as fuel for the body, and as the result of their combustion, heat and energy are generated. Both ultimately produce end-products which are removed from the body largely in the expired air as water and carbon-dioxide. Proteins also supply heat and energy, but they are used for another purpose as well; they form the bricks for building up the waste tissues of the body. That part of the protein molecule which is not required for the renewal of waste tissue is utilised for the production of heat and energy, just as in the case of fats and carbohydrates.

If we endeavour to follow the course of carbohydrate metabolism in the body, we are at once presented with many difficulties, but a few main features are fairly clear. It is certain that starch, no matter in what form it is taken in, is broken down in the intestinal canal by enzyme action into the simple sugar known as glucose. This glucose is then absorbed into the blood, and before getting into the general circulation, passes through the liver. If a great deal of glucose is present, the liver stores part of it for future use, and thus prevents an excessive amount of glucose from being present in the blood at one time. The storage substance which the liver forms from glucose is a starch-like body known as glycogen. Though the chief depot for glycogen is the liver, a good deal is found in the muscles as well. This glycogen is gradually converted into sugar again in response to the requirements of the body, so that a certain amount of sugar is always available for oxidation by the tissues. There is now a good deal of evidence that another storage product besides glycogen is formed during sugar metabolism—the lactacidogen of Embden—but it is doubtful whether this substance, which appears to be of the nature of a compound of sugar and phosphoric acid, ever gives rise to sugar again in the muscles after it is formed. When sugar reaches the tissues it is burnt up and forms carbon-dioxide and water. Many investigations have been carried out in an endeavour to find the intermediate substances between these end products and the larger sugar molecule, but of this phase of metabolism we know nothing with certainty.

Fat is also acted on by the intestinal juices and absorbed as free fatty acids and glycerin; it is largely stored as fat in the body. Before final oxidation, fat is broken down into a lower four-carbon fatty acid—oxybutyric acid—together with diacetic acid and acetone. These substances are then oxidised, forming the usual end-products, carbon-dioxide and water.

It is probable that both fat and carbohydrate have a definite and separate mechanism for metabolism, but that protein, on the other hand, does not possess a separate mechanism. When tissue waste is restored, the remaining protein is broken down into substances similar in nature to the intermediate products of sugar and fat metabolism, which are probably oxidised by the same mechanism as is used for fat and carbohydrate.

[1] Discourse delivered at the Royal Institution on March 28.

Metabolism in Diabetes.

In diabetes the carbohydrates are as usual hydrolysed to glucose in the intestinal tract, but after absorption the glucose tends to accumulate in the body, with the result that a certain amount of it is excreted in the urine. This excess of sugar in the body in diabetes depends on two causes. In the first place, the liver and muscles are unable to store the excess of sugar as glycogen, while in the second place, the tissues have lost to a great extent the power of oxidising sugar. The consequence is that a great deal of glucose is always present in the blood, resulting in a great waste of sugar through the kidneys. It is an interesting fact that one of the earliest manifestations of diabetes appears to be a lack of power on the part of the liver to store sugar as glycogen. This difficulty may be in evidence long before any symptoms of diabetes manifest themselves. In severe cases, oxidation of the sugar is also markedly interfered with, a phenomenon which depends on a lesion of the pancreas; this defective oxidation is most marked in the later stages of very severe diabetes. Generally speaking, sugar passes into the system of the diabetic and is largely passed out again without being utilised. Why this should be so is at present unknown, though various suggestions have been made.

The chemical researches of Fischer and of Irvine have demonstrated the existence of a more active form of glucose than the ordinary variety found in diabetic urine, and it has been surmised that this more active γ-glucose might be the form which the body requires for metabolism. If the body can utilise glucose only after it has been changed into the more active form, it is obvious that a defect in the mechanism responsible for this change would result in a condition similar to what we have in diabetes. The body would be supplied with a variety of sugar which it could not metabolise, with the result that this sugar would be excreted in the urine like any other foreign body. Attractive as this theory appears, it must be admitted that, so far, no convincing evidence of the existence of γ-glucose in the body has been advanced.

With regard to the metabolism of fat in diabetes, it appears that the breaking down of the large fatty acid molecule goes on as usual to the stage of ketone bodies, but that these bodies fail to be oxidised; they therefore accumulate in the blood and are largely excreted in the urine.

As already explained, the oxidation of protein probably takes place partly along the path of carbohydrate metabolism, and partly along the path of fat metabolism. The result is that protein may give rise to both sugar and ketone bodies in the diabetic urine, about 60 per cent. of the amino acids of protein being capable of forming sugar, while 40 per cent. may be excreted as ketone bodies.

The total result of these changes in metabolism is that the urine of the diabetic subject frequently contains large amounts of glucose together with oxybutyric acid, diacetic acid, and acetone.

The diagram (Fig. 1) indicates roughly what happens in metabolism in both the normal and diabetic person. These observations make it clear that no change in the particular class of food-stuffs taken will necessarily result in the elimination of sugar and ketone bodies from the urine.

Blood Sugar Changes in the Normal and in the Diabetic Subject.

Some knowledge of the physiological changes which the blood sugar concentration undergoes in the body is essential in the study of diabetes. In the normal subject, when the blood is examined two or three hours after a meal, it is found to contain about 0·1 per cent. of glucose. As a rule the blood sugar does not sink appreciably lower than this in ordinary circumstances. After the ingestion of carbohydrate food, however, it rises to a maximum of about 0·16 to 0·18 per cent. and then quickly falls to the former level of about 0·1 per cent. Usually the maximum rise takes place within one-half to three-quarters of an hour after a meal, and generally the blood sugar content is found to be normal in about one and a half to two hours. These changes are best observed after a meal consisting of from forty to fifty grams of glucose. It might be thought that the early rise just described is due simply to increased absorption of sugar into the blood and that the fall towards the normal level merely indicates that absorption is complete. This is by no means the case, as can easily be shown by experiment. Indeed, it would seem that absorption of sugar may be going on just as rapidly after the blood sugar falls to the normal level as it was when the blood sugar was at its maximum.

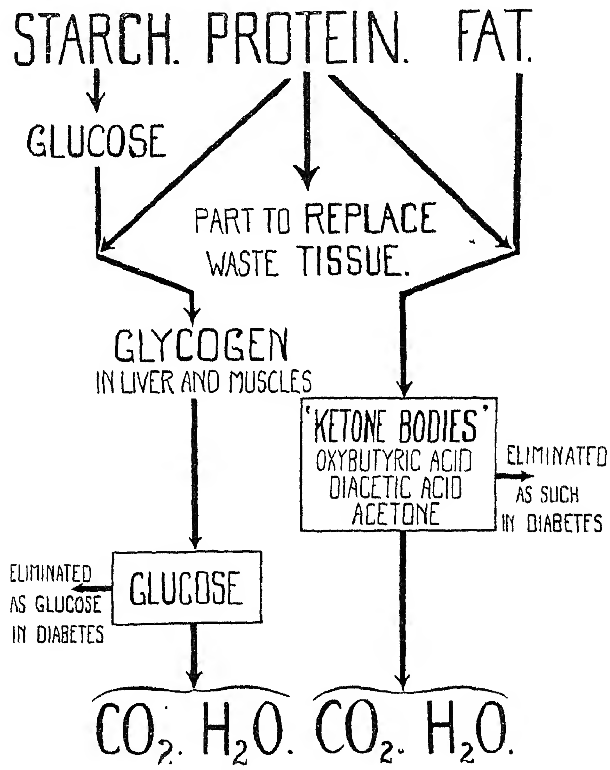


Fig. 1.—Metabolic paths of food-stuffs in the body.

The explanation of the phenomenon appears to be that, after some absorption of sugar into the general circulation has taken place, a special mechanism comes into action which stores the sugar as glycogen and so reduces the amount in the blood; this mechanism

resides chiefly in the liver. In connexion with this storage action it is interesting to observe that it is generally quite impossible to raise the blood sugar concentration beyond 0·18 per cent. or so. No matter how much sugar is taken, no greater quantity than this will be found in the blood. Whenever the concentration reaches this point, the liver storage mechanism becomes so strongly developed as to prevent any further rise. The interest of this observation lies in the fact that whenever the blood sugar rises above 0·18 per cent., the kidney begins to excrete sugar in the urine. Until this concentration is reached no sugar is excreted. The difficulty of raising the blood sugar beyond 0·18 per cent. or so indicates that glycosuria in the normal subject should be very difficult to produce as the result of ingesting large amounts of sugar, and experiments show that no sugar appears in the urine of the healthy subject however much sugar he eats.

From these statements it will be clear that the presence of sugar in the urine indicates that the blood sugar concentration is in the region of 0·18 per cent. or higher. Though the normal kidney does not excrete sugar until this concentration is reached in the blood, it sometimes happens that the kidney may leak and allow sugar to pass into the urine when the concentration in the blood is much lower than the figure given. This condition, which is fairly common, is known as renal glycosuria; obviously it has nothing whatever to do with diabetes. It gives rise to no symptoms and produces no bad effects.

In diabetes the glycosuria is always due to an increased amount of sugar in the blood—a hyperglycæmia—and the changes in blood sugar concentration after eating starch or sugar are very different from those in the normal subject. If fifty grams of glucose are given to a diabetic subject, the rise in blood sugar is much higher than in the normal, and it continues high for a much longer period. Generally, of course, it happens that the blood sugar in the diabetic is much higher to begin with than it is in the normal subject, but it may often be reduced by appropriate dieting to the region of 0·1 per cent., and when this is done and sugar is taken, the blood sugar soon shoots over the 0·18 per cent. mark and often reaches 0·3 per cent. or more, at which high level it may remain for hours. The curves in Fig. 2 represent the effect of 50 grams of glucose on the blood sugar of a normal and a diabetic subject. It is interesting to note that the only sugar which does not raise the blood sugar in the normal subject is lævulose; in the diabetic, however, lævulose acts just as any other sugar. An appreciation of these facts is necessary in order to understand the action of insulin.

Glycosuria not Diabetes.

Though glycosuria constitutes an important symptom of diabetes, it must be clearly understood that the finding of even large amounts of sugar in the urine does not necessarily mean that diabetes is present. When glycosuria results from a leakage of sugar through the kidney, the condition is obviously of little or no importance, as already explained. Temporary glycosuria is not infrequently produced as the result of such conditions as mental excitement and fear. The explanation that has been suggested by physiologists to account for the increase of blood sugar caused by fear, is, that under primitive conditions some degree of fear was generally a preliminary to active muscular exertion of a defensive nature, and that the sugar was provided as fuel for the production of the required energy. Again, it is very common to find sugar in the urine of students after an examination. An interesting observation bearing on this point was reported some years ago by certain American observers. They examined the urines of a number of male students after an examination and found sugar in 18 per cent. of them. On extending the experiment to female students, contrary to expectation, no such result was in evidence, but since these latter students were all much younger than the males, it is probable that the irresponsibility of youth rather than any fundamental lack of emotion

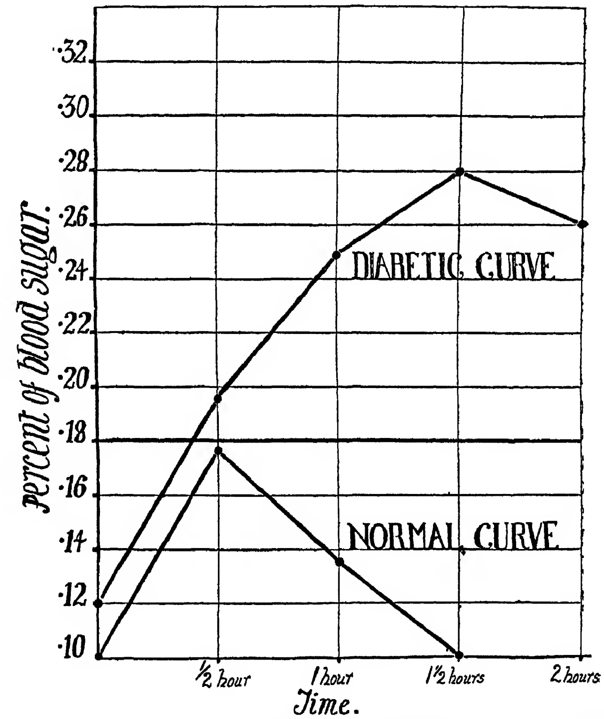


Fig. 2.—Curves of blood sugar concentration obtained from a normal and a diabetic subject after giving each 50 grams of glucose by mouth.

was the cause of the difference. Glycosuria also appears as the result of taking various drugs, and is not very uncommon in elderly patients who practise the belief so widely prevalent that rejuvenation and restoration of bodily and mental vigour may be obtained by the ingestion of large amounts of thyroid gland extract. Another cause of glycosuria not infrequently encountered is the excessive use of alcohol. After long dinners in which alcohol may play but a moderate part, glucose is frequently found in the urine on the following day. All these conditions are dependent on a temporary hyperglycæmia, but they disappear whenever the condition giving rise to them is removed. This glycosuria must not be regarded as of a diabetic nature.

Chief Symptoms of Typical Diabetes.

Along with the blood and urine changes described above, the diabetic suffers from general weakness,

marked emaciation, great mental depression, thirst, hunger, and a very great tendency to the onset of a most serious condition associated with drowsiness and ultimately resulting in unconsciousness and death; this latter state is the fatal condition known as diabetic coma. It is liable to appear sooner or later in every case of severe diabetes, and apart from accidental complications, is the usual cause of death in the diabetic subject.

Though this is the general course in typical diabetes, it must be admitted that the progress of the malady varies much in different individuals, and that many varieties of the disease, from a chronic slowly progressive type to what might almost be called fulminating diabetes, are encountered. Before the advent of insulin it was quite the exception for a patient suffering from well-marked diabetes to live for more than five or six years, though sometimes this period could be extended by careful dieting. This class of case is easily recognised and represents typical diabetes mellitus.

Another variety of so-called diabetes is by no means uncommon in middle-aged and elderly individuals. The patient may feel quite fit, or more frequently he complains of being somewhat out of sorts, with weakness of the limbs and a feeling of tiredness and lack of energy. On examination of the urine a large amount of sugar is found, but no ketone bodies are present. Unlike the true diabetic, there is no emaciation; indeed such a patient frequently tends to get excessively fat. The presence of this condition is not incompatible with the enjoyment of more or less good health for very many years during which sugar is continually passed, and frequently there does not appear to be any progressive tendency on the part of the disease. In such cases there is no danger whatever of coma intervening, and it is obvious that the condition differs essentially from that of true diabetes. Indeed, the patient is not really suffering from diabetes at all, but from a well-marked and persistent glycosuria; his urine contains none of the toxic metabolic products characteristic of diabetes.

What happens in this type of case is that the liver has to a large extent lost the power to store sugar as glycogen, with the result that there is constantly a more or less excessive amount of sugar present in the blood, giving rise to glycosuria. Unlike what occurs in true diabetes, where a definite defect in the pancreas is present, there is here apparently no difficulty in oxidising sugar or fat in the tissues, hence the absence of ketone bodies in the urine. The constant excess of blood sugar probably stimulates the pancreas to produce more insulin, with the result that a good deal of this sugar is stored as fat in the same manner as the diabetic patient treated with insulin tends to put on fat. Occasionally, though not very frequently, this type of persistent glycosuria develops after many years into a true diabetes. This somewhat rare contingency appears to depend on the fact that the large amount of blood sugar constantly present stimulates the pancreatic cells to an over-activity which sometimes results in exhaustion. While true diabetes is probably always associated with a pancreatic lesion, the type of so-called diabetes just described appears to be dependent on a disturbance of the liver. Though, in true diabetes, the liver also fails to store sugar, yet this is but one part of the condition; the most important point is that oxidation of sugar and other foodstuffs is defective. In the glycosuria of elderly individuals the defect appears to be limited to the liver.

The Cause of Diabetes.

The older observers appear to have been impressed by the frequency with which patients dying from diabetes showed definite lesions in the pancreas, and the older literature contained many statements emphasising this point. It was not, however, until 1889 that the relationship of the pancreas to diabetes was definitely established. In that year, von Mering and Minkowski, in an epoch-making paper, showed that the removal of the pancreas from an animal resulted in a condition which was practically the same as severe human diabetes. Removal of part of the gland might or might not produce glycosuria according to the amount of healthy tissue left behind, but complete extirpation was followed in every case by intense symptoms and a fatal termination in coma within a few weeks. Evidence was obtained that this result was not dependent on the loss of the ordinary pancreatic tissue, and it is now generally accepted that certain small islands of special cells found in the pancreas—the Islets of Langerhans—are connected with carbohydrate metabolism and that their destruction or removal results in diabetes. These important experiments constitute the foundation on which all subsequent advances in our knowledge of diabetes, including the discovery of insulin, are based.

Attempts to obtain Pancreatic Extracts for the Treatment of Diabetes.

The discovery that destruction or removal of the pancreas in animals gave rise to diabetes at once suggested the idea that this disease might be successfully treated by giving pancreas or pancreas extract to the patient. It was obvious that the pancreas must contain some active principle which was necessary to prevent diabetes, and the natural inference was that if this substance could be supplied to the diabetic, the symptoms of diabetes would disappear. At first, fresh pancreas or various extracts of the gland were given by mouth, but without any apparent effect. Later, various special preparations were tried by injection, but the results, though by no means always negative, were variable and unsatisfactory. It may with confidence be said that practically every investigator interested in diabetes has at some time or other tried the effects of pancreatic extracts.

It soon became clear that no effect whatever was produced when the preparations were given by mouth, but several observers had quite marked results when hypodermic or intravenous administration was used. Thus, for example, Zuelzer in 1908 prepared an extract which he injected into diabetic patients, with the result that, though no change was made in the diet, the sugar and ketone bodies previously present in the urine were much reduced or, indeed, in some cases disappeared altogether. At the same time the patients improved in general health. The method was, however, given up on account of the frequency with which injections were followed by more or less serious disturbances in the patients, some of whom became very ill, while others showed high fever, rigors and prostration. Zuelzer's product was prepared from the pancreas by

the use of alcohol. He assumed that the active principle was easily destroyed by the pancreatic ferment, and took the view that this might be prevented by treatment with alcohol. Later, Scott, working in America on somewhat similar lines, obtained a preparation which was definitely active though rather weak and inconstant. Various observers had somewhat similar experiences, but nobody was able to prepare a trustworthy non-toxic substance for clinical use in diabetes, and a few years ago it seemed as if the problem was insoluble. The disappointing results of so many investigators tended to substantiate the impression that further work on the problem was not likely to produce results, and our earlier hope of being able to treat diabetes successfully by pancreatic extracts had to a large extent vanished.

This was really the position when Banting took up the subject. Banting adopted the view propounded by many earlier investigators that the trypsin of the pancreas destroyed the internal secretion or hormone necessary for normal carbohydrate metabolism, and that the failure to obtain an active substance depended on this digestive action of trypsin. The difficulty was to devise some means by which this destructive action of trypsin during extraction of the pancreatic tissue could be avoided. It was well known to physiologists that the ordinary pancreatic tissue which secretes enzymes for the digestion of food underwent degeneration after ligature of the pancreatic duct, while on the other hand the islets of Langerhans were not affected. Banting therefore tied the duct in an animal and after several weeks removed the degenerated pancreas. If the theory mentioned was correct, an extract of this pancreas should contain an active substance for the treatment of diabetes since no digestive enzymes would be present. This actually proved to be the case, for a simple saline extract of this pancreas when injected into a diabetic animal lowered the blood sugar and reduced the amount of sugar passed in the urine.

This result was exceedingly interesting, but its practical application on a large scale was obviously impossible. Fortunately, however, it was soon found that the initial tying of the duct was unnecessary, for further experiment on the lines of Zuelzer's work showed that quite active preparations could be obtained from the normal pancreas. Ox pancreas was macerated as soon as possible after the death of the animal and left standing for several hours in 95 per cent. alcohol. The mixture was then filtered and the clear fluid obtained evaporated to dryness by means of a current of warm air. The residue was then dissolved in saline and used for injection. To this active substance Banting gave the name "Insulin."

It is not quite certain whether Banting's original view is correct, but this is of little importance from the practical point of view. Banting's success was largely dependent on the ease with which blood sugar can now be estimated, for it was essential in judging of the effect of insulin on animals that blood sugar estimations should be carried out at frequent intervals. Some years ago this was practically impossible, but now blood sugar may be estimated in the same animal every few minutes if necessary. To Banting belongs the credit of having prepared an active extract of pancreas suitable for the treatment of diabetes, but it must not be forgotten that this great achievement was rendered possible only by the laborious work of many earlier observers. Banting's final triumph was no doubt largely brought about as the result of modern developments in biochemical methods, but, taking everything into consideration, it still remains a mystery why insulin was not isolated many years ago.

As was the case with all former investigators, Banting's earlier products frequently gave rise to more or less alarming symptoms when injected into patients, so attempts were made to obtain a purer substance. These attempts were successful, and samples of insulin were soon prepared which possessed little or no toxic effects. The present method of manufacture depends on the isolation of a crude product by fractional precipitation of pancreatic extract with alcohol; this impure body is treated with picric acid, and insulin picrate precipitated, from which a fairly pure substance suitable for clinical work is obtained. This method requires the use of large amounts of alcohol and is somewhat tedious and expensive; also, it takes several days to complete the extraction and preparation of the insulin. Quite recently, Dodds, at the Middlesex Hospital, worked out a process for the isolation of insulin which possesses many advantages over the usual method in vogue. The principle of this method is based on the earlier observation by Dudley, that insulin could be most conveniently separated as the picrate. In the modification suggested by Dodds, the fresh pancreas is thoroughly ground up with solid picric acid, thus converting the insulin directly to picrate and so reducing the time during which tryptic action may occur. By this process the old tedious filtration of the alcoholic extract is rendered unnecessary. The pancreas-picric acid creamy mixture is treated with acetone, which dissolves out the insulin picrate. The picrate is then purified on the usual lines. Not only is this method more expeditious, but also it actually gives a higher yield of insulin.

Standardisation of Insulin.

The effect of insulin in reducing the blood sugar is not confined to diabetic animals, for it reduces the blood sugar of normal animals as well. This effect of insulin is used in the standardisation of the product for clinical use, and the present unitage is based on the dose required to reduce the blood sugar of a normal rabbit to about 0·04 per cent. An average dose for a diabetic patient is 10 units, but the amount given depends on the gravity of the condition.

Symptoms produced by Insulin.

In both the normal and the diabetic individual, insulin may produce definite symptoms when given in excess. The chief of these symptoms are hot flushes especially on the face, weakness of the limbs, giddiness, sweating, tremulousness, and ultimately, if the condition is not relieved, convulsions, coma, and death. This property of insulin makes the remedy a very dangerous one unless great care is used in its administration, and no doubt explains many of the difficulties encountered by the earlier investigators.

The occurrence of these clinical phenomena is associated with the action of insulin in reducing the blood sugar. When the blood sugar gets too low, the fact

is indicated by the appearance of these symptoms, but it is now certain that patients differ greatly as to the exact blood sugar concentration that may be present when the symptoms come on. Taking the normal resting sugar as about 0·1 per cent., it would seem that in certain subjects, even a slight decrease to about 0·08 per cent. or so may be associated with insulin symptoms, while, in others, the blood sugar concentration may be so low as 0·05 per cent., and yet the patient may feel quite well. In a general way, it is now established that the train of symptoms induced by insulin do not appear when the blood sugar is normal or above this level, but that they are liable to manifest themselves whenever the blood sugar sinks to a sub-normal value; the exact level at which they appear depends on some unknown factors present in the patient. The association of these insulin symptoms with a more or less lowered blood sugar concentration—a hypoglycæmia—is, however, so pronounced that they are generally referred to as hypoglycæmic reactions. It may be taken for granted that when insulin symptoms do come on, the lower the blood sugar the more severe are the symptoms likely to be. Fortunately, these symptoms are very soon relieved if some glucose is taken, so that, generally, this insulin hypoglycæmia is not dangerous, provided that the patient is warned as to the nature of the symptoms, and takes glucose immediately they come on. In certain circumstances, however, the condition may be a very real danger, as every one who has treated many patients must have found.

The curious variation to the influence of insulin which exists in normal individuals is well shown by the results of an experiment carried out in my laboratory on two young healthy medical men each about the same build, age, and weight. For a day or two before the test, both subjects took the same amount and the same kind of food. On the morning of the experiment each received 50 grams of glucose by mouth, and shortly afterwards 20 units of insulin were injected hypodermically. Samples of blood were then taken at frequent intervals for blood sugar estimations. One subject showed no symptoms whatever after the insulin, while the other developed symptoms so severe that it was difficult to get blood for sugar estimations. A further 50 grams of glucose given by mouth had a marked but only a temporary effect in relieving these symptoms, so that very soon the condition was as severe as before and indeed somewhat alarming. A further 60 grams of glucose was then administered with the result that the insulin phenomena passed over once again, though some slight symptoms reappeared later. So far as blood sugar concentration was concerned, there was little difference between the subjects; in both the blood sugar fell to the region of 0·07 to 0·08 per cent. The description of his symptoms given by the subject who suffered from insulin symptoms was as follows: "The first noticeable symptom was profuse sweating of the face, scalp, and neck. This was very quickly followed by inability to perform fine movements with the hands, and weakness of the legs, which, however, was only noticed when standing up. General symptoms were dizziness, and an impression as of all near objects being far away and having a swaying movement. On recovery after glucose, the sweating, dizziness, and swaying sensations were the first to go; the sense of weakness in the limbs remained for the longest time."

In the treatment of insulin hypoglycæmia, there is no difficulty in administering sugar provided the patient is still conscious; on the other hand, when the patient is unconscious, it may be very difficult indeed to get sugar into the system. In such cases the patient may generally be brought round by the injection of 1 c.c. of 1 in 1000 adrenalin solution. A dose of pituitrin (1 c.c.) given subcutaneously will also produce the desired result. If, however, consciousness is not soon restored by these methods, glucose must be injected into the circulation through a vein. This procedure never fails to bring the patient round, provided the hypoglycæmic condition has not lasted too long.

Though severe hypoglycæmic phenomena with unconsciousness were observed fairly often some time ago when our knowledge of the action of insulin was very limited, they are very seldom encountered at the present time, and should never ensue when the use of insulin is founded on a correct perception of its action and properties.

The Use of Insulin in Diabetes.

From what has already been said, it is obvious that insulin does not cure diabetes. Insulin merely replaces a missing substance in the body of the diabetic, and so long as a suitable dose of insulin is being administered, the patient is free from symptoms and feels well both physically and mentally. When the administration of insulin is stopped, the old symptoms reappear. In a typical case of diabetes the results produced by insulin are frequently dramatic. From being a weak, depressed, emaciated wreck, the diabetic very soon becomes a strong, energetic individual. The sugar and ketone bodies disappear from the urine, and there is nothing to indicate that the patient had ever been the subject of diabetes.

Suggestions have been brought forward in some quarters that the vigorous use of insulin may so rest the pancreas that a great improvement in tolerance may be established, and that in some cases a cure may be effected. In my opinion, there is no basis for this expectation, and it is unlikely that insulin will do more in this direction than will a carefully regulated diet. There is a feeling among the public that once insulin is used, it must be administered permanently, for it is believed that the condition of the patient who stops taking insulin is worse than if he had never begun it. This, however, is not so, for a patient may cease to take insulin and be no worse than he was before. Insulin is given by hypodermic injection, the average dose being from 10 to 20 units twice daily. It is usually injected about a quarter to half an hour before food, and is given in the morning and at night, before breakfast and dinner respectively.

One of the most important points in the use of insulin is that the diet should be carefully correlated with the insulin dosage. As a rule, one unit of insulin will "look after" about two to three grams of carbohydrate, so that it becomes most important that an excessive amount of food should not be taken. It is just as necessary for the patient on insulin to follow definite rules as regards food, as it is for the diabetic patient who is being treated by diet alone. The only

difference is that the insulin patient can take a more liberal diet. Once the diet is fixed, it must be adhered to, for a difference in diet would necessitate a difference in dosage of insulin, with the result that at one time the patient might be passing large amounts of sugar, while at another time the insulin might be in excess in relation to the diet, and the patient might suffer from the insulin symptoms already described. I have seen a patient who was taking a fairly large dose of insulin (20 units twice daily), but paying no attention to his diet, pass into diabetic coma.

Insulin and Pancreatic Preparations given by Mouth.

Insulin has practically no effect in lowering the blood sugar when given by mouth; the reason for this is that insulin is very easily destroyed by the ferments present in both the stomach and intestine. These ferments produce their injurious action very rapidly, so that insulin is destroyed before it can be absorbed. Various attempts have been made to give insulin by mouth in association with some substance known to undergo very rapid absorption, and, in this connexion, claims have been put forward that when insulin is taken in alcohol a fair amount of it is absorbed and produces, to some extent, its usual effect of lowering the blood sugar. These claims, however, have not been generally substantiated.

At present there are numerous pancreatic preparations on the market for which the claim is advanced that when taken by mouth they relieve the symptoms of diabetes. It is not always quite clear whether the vendors of these preparations claim that their products contain insulin, but since insulin is destroyed in the alimentary tract, it is obvious that any such claim is of no importance, for even if these preparations did contain insulin, they would be of no therapeutic value when taken by mouth. It is conceivable, however, that pancreatic preparations given by mouth might exert a beneficial action on diabetes apart altogether from the action of insulin. With the view of investigating this point I have tried nearly all the well-known preparations of this kind on the market. So far as my observations go, it would seem as if all these products given by mouth are of no value whatever in the treatment of diabetes.

Some Difficulties accompanying the Use of Insulin.

Naturally, the injection of insulin two or three times a day causes some physical discomfort, but when sharp fine needles are used this is not an important feature, and patients do not mind the slight pain of the injection. Sometimes there is a definite local reaction which may give rise to marked swelling and redness at the site of injection. This reaction generally persists for about twenty-four hours, after which it gradually disappears. As more experience in the manufacture and purification of insulin is gained, these local reactions appear to be less and less frequently encountered, and at the present time no great amount of trouble is experienced on this account. Sometimes, especially during the early stages of insulin treatment, the legs begin to swell somewhat, but this soon disappears.

Continuous administration of insulin over long periods tends to produce a hardening of the skin around the site of injection, so that after some months, a large area of the arm or leg may be markedly indurated. By varying the site of injection, and using different parts of the body, this difficulty may be largely overcome. It must be admitted, however, that the continuous administration of insulin to children is not always an easy problem, for the available surface for injection is not very large, and the skin of both arms and legs sometimes becomes so hard that it is difficult to insert the hypodermic needle. It is usually found that adult patients can inject themselves quite satisfactorily. On the whole, injection of insulin when carefully done does not give rise to so much difficulty as might perhaps be expected, but, on the other hand, there is no doubt that the advent of an effective preparation that could be given by mouth would be a very great practical advance in diabetic therapy.

Diet in Insulin Therapy.

In order to obtain the best results from insulin, it is necessary to put the patient on a special diet containing but a small amount of carbohydrate, the rest of the diet being made up of protein and fat. The amount of food required by a diabetic patient varies according to many conditions such as age, weight, and the amount of work done. It is now customary to express dietetic values, not by the weight of material consumed, but in terms of heat value or calories.

For practical purposes it may be accepted that 1 gram of protein or 1 gram of carbohydrate is equivalent to 4 calories, while 1 gram of fat is equivalent to 9 calories. Now a patient requires roughly a diet that will contain from 10 to 15 calories for each pound he weighs. Thus a patient weighing 140 pounds would require a diet containing from 1400 to 2000 calories, or he would probably do quite well on a diet containing about 1700 calories. In ordinary circumstances, he would no doubt consume considerably more than this. It is essential that the diet should contain some protein, and 0·5 gram or somewhat less for each pound the patient weighs is generally required. Since the carbohydrate allowance is necessarily small, insulin diets usually contain a fairly large amount of fat. Carbohydrate should, if possible, be given in moderate amount, for it ensures safety in the use of insulin, especially during the earlier stages of treatment, and makes the diet more palatable.

Prevention of Insulin Symptoms.

Since insulin symptoms do not come on until the blood sugar is reduced considerably below 0·1 per cent., it follows that no such symptoms are ever in evidence so long as the diabetic passes even a very small amount of sugar in his urine. Some medical men give just sufficient insulin to keep the urine almost but not entirely free from sugar, and thus guard against the onset of any insulin symptoms. Where facilities for blood sugar estimations are available, it is best, however, to give sufficient insulin to reduce the blood sugar to about the normal level.

Though some failures in the use of insulin have been recorded, it is my experience that this remedy never fails to act in typical diabetes; whereas, if the patient is suffering from some other malady as well as diabetes, good results cannot always be expected.

Mode of Action of Insulin in Diabetes.

Insulin very soon reduces the blood sugar in diabetes and eliminates glycosuria even in some patients when comparatively large amounts of carbohydrate food are taken. Strange as it may seem, it appears to be definitely established that the sugar which disappears from the blood as the result of insulin injection does not form glycogen. In rabbits fed on carbohydrate and treated with insulin, little or no glycogen is present, while in well-fed ordinary rabbits not treated with insulin, large amounts of glycogen are found. It is, therefore, obvious that the carbohydrate metabolism of the normal individual may be different in degree at any rate from that which obtains in the patient whose metabolism is helped by the use of insulin.

One of the most impressive features of the insulin patient is the extreme tendency to put on fat. Experiment shows that the sugar which has disappeared does not form fat *directly*, though there is little doubt that it does so indirectly. If we accept the view, which appears to be fairly well established, that insulin does not form glycogen from sugar and does not *immediately* and *directly* form fat from sugar, we are confronted with the problem as to what does happen to the sugar. Increased combustion will not account for the disappearance, so part of it must be stored in some form in the body. There is a good deal of recent evidence that some of it, at any rate, is stored in the body as a combination of glucose and phosphoric acid—Embden's lactacidogen—for experiment seems to show that insulin increases the amount of this substance in the body. Very probably this complex represents an intermediate product on the way to fat formation. The problem of the action of insulin is, however, far from settled, for insulin has a profound effect on both fat and protein metabolism.

The Future of Insulin Therapy.

That insulin relieves the symptoms of diabetes there is no doubt whatever, but, unfortunately, its action is very liable to be interfered with by such causes as cold, an attack of influenza, a mild gastric upset, or almost any slight departure from normal health. The use of gas for removal of a tooth may cause a similar disturbance. In such cases, patients who were free from glycosuria and progressing satisfactorily may begin to pass large amounts of sugar in the urine, and may even suffer from marked diabetic symptoms. In these patients the dose of insulin must be very largely increased, but the correct dose may be difficult to determine. These interferences with the action of insulin render it necessary to keep patients treated with insulin under careful observation. Again, the fact that injection is necessary for the rest of the patient's life makes the use of insulin tedious and not altogether free from physical discomfort. It is difficult to contemplate children going on for forty to fifty years or more having two injections of insulin daily, and no doubt, in spite of insulin, many diabetic children will succumb to intermittent affections.

It is, of course, too early to say what the ultimate effects of insulin will be in the general treatment of diabetes. There is already a good deal of evidence pointing to the conclusion that some patients become, to some extent, accustomed to its action, so that larger and larger doses are necessary. This necessity for larger doses may only indicate a steady progression of the lesion, but a somewhat similar phenomenon is encountered in normal rabbits, which, when injected on several occasions with insulin, gradually show a markedly decreased response to each administration. Recently, some experimental evidence has been brought forward suggesting that, in normal circumstances, carbohydrate metabolism may be somewhat different from what it is under artificial insulin injection. Thus, when a dog is rendered diabetic by total removal of the pancreas, it is apparently impossible to prolong life *indefinitely* by the use of insulin, though, naturally, the dog can be kept alive by insulin for many months.

It might, therefore, be argued that there may be some cases of human diabetes comparable with the condition in the dog in which no active pancreatic tissue is present. In the ordinary diabetic subject there are, of course, some more or less active pancreatic islets left, and further, there is no evidence that the production of pancreatic digestive ferments is at all interfered with. In the depancreatised dog no pancreatic digestive ferments are present, and so intestinal digestion is markedly upset. It has, therefore, been suggested that the inability to prolong the life of the depancreatised dog indefinitely by means of insulin depends on the absence of digestive ferments, and chiefly on the inability to hydrolyse fat.

While this is a possible explanation, it does not seem to be a very probable one, for it has been shown that the depancreatised dog may apparently be kept alive indefinitely, provided a *very small part* of the pancreas is left behind. If these experiments are substantiated, it is not likely that the absence of digestive ferments plays much part in the depancreatised animal, for the amount of digestive ferment secreted by a very small piece of pancreas would scarcely be sufficient to influence the fat metabolism. Indeed, the evidence available at the present time points strongly to the probability that the pancreas forms another hormone essential for the process of normal carbohydrate metabolism besides insulin, and that unless this hormone is present, insulin alone will not sustain life for a long period.

From the clinical point of view, the above assumptions appear to be strongly borne out, and it appears certain that the use of insulin does not serve as a substitute for the normal mechanism. There are such marked differences between a normal individual and a diabetic under treatment with insulin that it is quite certain that the processes in the normal individual are in some way very different from those occurring in the diabetic individual. On the whole, so far as our present experience goes, it would appear that the average human diabetic patient can be kept alive for long periods by the use of insulin, so that, in the absence of accidental circumstances, the diabetic on insulin treatment may expect to live to a normal average age.

Great as have been the results obtained by insulin therapy, it has not yet provided a substitute for the normal process from the clinical point of view, and much has yet to be achieved. On the other hand, the marvellous success of insulin in the treatment of severe and otherwise hopeless cases of diabetes is one of the most striking triumphs in the whole field of modern therapeutics.

Printed in Great Britain by R. & R. Clark Limited, *Edinburgh*

NATURE

SATURDAY, JULY 12, 1924.

CONTENTS.

Editorial and Publishing Offices.
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2

Editorial communications should be addressed to the Editor.
Advertisements and business letters to the Publishers.

Telephone Number: GERRARD 8830.
Telegraphic Address: PHUSIS, WESTRAND, LONDON.

Europeans in the Indian Services.

THE story of the British servants of the Indian Government falls naturally into three periods. In the first period the Britisher (we cannot say Englishman because he was more often Scotch or Irish) usually gave up his native land, adopted India as his country, often took an Indian wife, and had a real chance of understanding the people he ruled. There were then few white women in India.

The transition to the second period was due to improved means of transport. The Britisher in the Indian Service no longer settled permanently in India, and he also normally brought with him a portion of European civilisation in the form of a wife. From the point of view of the welfare of India the change had a number of consequences. These British rulers were now birds of passage and thus had less opportunity and perhaps even less desire to understand the people. The introduction of European civilisation to India increased his separation from the people. The European wife disapproved of the earlier unions and their offspring, and the Eurasian, who might have continued to rank almost as high as the European if the first period had continued, now fell seriously in public estimation. Moreover, the presence of a wife and children was apt to affect the nerves of men who in their absence would have faced any situation with perfect equanimity; the Mutiny still casts a shadow. But the greatest weakness (a weakness shared with the first period) was the absence of contact between the educational and political sides of the Government. On the educational side the Government was teaching the people respect and admiration for democracy, while on its administrative side it remained a benevolent despotism. So apt a pupil as the Indian could not be expected to refrain from a demand for democratic institutions; which brings us to the third period.

The Morley-Minto reforms were not effectively in the direction of democratic government, and the third period dates from the Government of India Act of 1919 which gave effect to the Montague-Chelmsford reforms and introduced a degree of representative government under the system called "dyarchy." Under this system government activities fall into three classes:

1. Central services carried out for the whole of India by the Government of India.

2. Services entrusted to the local government acting on democratic lines, that is, entrusted to the governor acting on the advice of ministers responsible to a legislative council (called "transferred services").

3. Services entrusted to the local government on the old lines, the governor acting at his own discretion uncontrolled by the legislative council (called "reserved services").

The setting up of dyarchy inevitably raised certain problems, and it is the solutions to these problems offered in the report of the Lee Commission [1] that we have now to discuss. The problems were in effect (1) how should the staff required to carry out the transferred services be recruited and controlled, and (2) what proportion of Europeans should there be in the personnel of each of the services and how is the necessary number of suitable Europeans to be obtained. The principle of dyarchy gives the reply at once to the first question. The transferred services belong to the local government acting in its democratic capacity, that is to say, the officers are the servants of the legislative council, the orders of which they receive through the governor and ministers; and the appointment and control of the officers who carry out these duties must also be the affair of the governor and ministers acting for the legislative council. Accordingly the report proposes that for the education service, the agriculture service, the veterinary service, and the roads and bridges side of the engineering service, no new appointments should be made on the present terms on which officers hold from the Secretary of State, and that new services should be instituted to be recruited and controlled by the local governments.

Into the problem of the European recruits a number of considerations enter: the fall in the value of money, the question of security of tenure, the prospects of promotion, the comparison of the future and the past in regard to the spaciousness of the European's life, and the interest and importance of his work.

The proposals of the Commission in the matter of security and of the fall in the value of money are of a kind that should enable good men to undertake the work. The question of promotion depends on the relative merits of the European and the Indian in the services. The highest posts of all must be considered as outside the reckoning of the European because under the parliamentary system they will go more and more to Indians. Against this is to be set the fact that a smaller proportion of Europeans are to be recruited, so that the proportion of good posts per European is increased, and if they show themselves better men than their Indian colleagues their flow of promotion should be greater.

The greatest change is in the nature of the duties. The benevolent despot dislikes the change and thinks it will ruin India. He has ruled the Indians all his life on the assumption that they are children and he cannot now look on them otherwise. He is consequently out of place in the new system. Instead of him we need a man prepared to respect the Indian as an adult human being, to sympathise with his desire for parliamentary government, and to teach him to run the parliamentary machine. While this may be a position of less personal grandeur than the benevolent despot enjoyed, it is one of greater human interest, and for the right man it will provide a life fully as attractive as the old. It is also possible that by regarding the Indians as adults with human feeling and a certain degree of judgment, and not as children, the future European servants of the Government may escape from the shadow of the Mutiny which has so overhung their predecessors.

For the purpose of carrying out the recruitment and control of the services that are in the future to hold from the Secretary of State or the Government of India, a Public Service Commission is to be established. It will be both judicial and educational. Its judicial functions will be connected with the disciplinary control and protection of the services while its educational qualifications will come in in relation to recruitment. The appointment of this Commission is a necessary development and was in fact prescribed by the Government of India Act of 1919, and in addition to this central Public Service Commission each province will find it necessary to set up a similar body to manage the recruitment and control of the officers employed on transferred services. This is recognised by the Royal Commission, which states in paragraph 30 "we are aware that any proposal that a central Public Service Commission should be empowered to interfere on its own initiative in provincial administration would be regarded as violating the principle of provincial autonomy."

It is rightly recommended that the knowledge and experience of the Public Service Commission should be placed at the disposal of any local government that chooses to use it. It is highly desirable that the local governments should take advantage of this opportunity, but any self-respecting government will shy off if the attentions of the Public Service Commission are thrust upon it, and yet in paragraph 27(3) the Royal Commission recommends that the Public Service Commission should be the final authority for determining "the standards of qualification and the methods of examination" for the local government services. This recommendation clearly violates the principle of provincial autonomy and cannot possibly be put into force; and the very fact that it is recommended may determine the local governments to have nothing to do with the Public Service Commission.

The truth is that the Royal Commission has given little attention to the machinery of recruitment. Witness the illogical minute on the London Open Competitive Examination which has been thought worthy of publication. Witness also the recommendation that the upper limit of age for the Indian Civil

[1] Report of the Royal Commission on the Superior Civil Services in India, dated March 27, 1924.

Service should be twenty-four, because the universities prefer that age, and the statement that "it was a corollary of the decision to reduce the upper age limit to 23 years that the period of probation for recruits should be extended from one year to two"; the truth being that the basic decision was for two years' probation and reduction of the upper age limit to twenty-three an inevitable corollary. In this connexion we should have expected the Commission to take some account of the fact that a probation of two years is already in force for the Indian Civil Servants recruited in India.

In spite of these blemishes to which we have thought it necessary to direct attention, the fact remains that the Royal Commission has done sterling work towards making the government service attractive to the European. Its work is in the main excellent, and the blemishes can easily be removed.

Southern Nigerians.

Life in Southern Nigeria: the Magic, Beliefs and Customs of the Ibibio Tribe. By P. Amaury Talbot. Pp. xvi + 356 + 32 plates. (London: Macmillan and Co., Ltd., 1923.) 21*s*. net.

"ONLY by the good will of the black men will it ever be possible for more than the faintest idea of his complicated psychology to be grasped by the white; and could but the educated negro be brought to understand that he has infinitely more to gain than lose by recording every scrap of information concerning native customs and beliefs—omitting nothing and concealing nothing—such a book might be written as has never yet seen the light of day." This expression of opinion sums up Mr. Amaury Talbot's whole attitude towards the African. His latest book, "Life in Southern Nigeria," is written not only with knowledge and experience, but also in a spirit of sympathetic understanding. As a guide for future administrators the work is invaluable, combining as it does the results of scientific research with an appreciative knowledge of the beliefs and superstitions of an ancient people.

The Ibibio, of whom the author writes, are a little-known people living in the south-eastern part of Nigeria. They number, in all, more than a million, of whom some hundred and fifty thousand inhabit the Eket district. This is Mr. Amaury Talbot's description of them: "The Ibibio are typical negroes, thick set, with long arms, short trunks, medium-sized legs and feet broad and flat. Their language belongs to the Semi-Bantu group with many and strong affinities to the Sudanic tongue of their neighbours, the Ibo, with whom they have much in common." Although, as the author points out, the march of Western civilisation results in the younger members of the Ibibio becoming Christianised, many of the older generation still cling to beliefs and ways unchanged since the childhood of the world. "For them," he writes, "the commonplace does not exist, each object is tinged with wonder and mystery, while forces benevolent or malignant are to be felt on every hand."

According to Mr. Amaury Talbot there are two forces which influence the life of the Ibibio, the Ndemm (meaning fresh water) and the Ibokk (often translated by Juju as well as by medicine). The first of these forces dwells in or near rivers, pools, springs, and trees. They are gnomes, salamanders, dryads, etc., and are supposed to be male and female. The Ibokk are natural or elemental forces, which do not affect, or come into contact with, human beings until made to by a doctor or "wise" man. An interesting chapter is one on magic plays, where the author describes what may be called conjuring tricks. "A vast concourse of people gather together and a baby is brought into their midst. The child is thrown into a fu-fu mortar and beaten to pulp before the eyes of all the people. Three men are chosen to eat the babe, and when all is eaten, they begin to dance. After a while the central figure shakes his leg violently and from the thigh the child appears."

The idea that the soul of man or woman has the power to leave its human form and enter into that of its "affinity" is firmly held by these people. In proof of this the author relates the story of a Yoruba steward, who was caught by a crocodile one evening and dragged below into the river. After investigation it was found that the crocodile was supposed to contain the soul of a Juju man who, when angered against the Government, wreaked his vengeance on the officials. On this particular evening he was especially incensed against an official who had reported his evil deeds, and waited until he could have his revenge.

There are, according to Mr. Amaury Talbot, three secret societies of the Ibibio, the Egbo, Idiong, and Isong. Their initiatory ceremonies bear a strong resemblance to Freemasonry, and any non-member attending the ceremony would be punished severely. In an interesting chapter entitled social organisation and tabu, the author lays stress on the fact that slaves taken in war were most kindly treated, and in many cases allowed to marry into their masters' family. Amongst the food taboos the animals forbidden were snakes, monkeys, and lizards. In this chapter Mr. Amaury Talbot relates an experience he had whilst District Commissioner. Three of the head chiefs

of Ikotobo came to him one morning trembling with fear, and asked him if it were true that he was going to use tonite for the removal of some tree-trunks which were blocking a certain creek. Mr. Amaury Talbot assured them that no orders had been given to that effect, and demanded the cause of their fear. The answer was as follows: "Deep down in the waters of the creek are tiny houses such as ants make. Near these houses live fishes, with skins as black as our own. In these fishes are the souls of our ancestors, and for every fish you would kill one of our people would die."

Space does not allow one to quote the telling descriptions of bush fires, wide expanses of beautiful scenery, or vast pools of water given in this book. With regard to fire-worship, which still goes on, the author says: "In lands where such demonstrations of the power of fire are matters of constant occurrence, it is not to be wondered at that many rites of fire-worship should here still form part of the race. On a certain day in the wet season some towns, for instance, make two great bonfires, one on each side of the road. Then they gather their cattle, sheep, and goats into a herd and drive them between the walls of flame. This ceremony is said to destroy evil influences which might otherwise have caused sickness to fall upon the beasts during the year, and is also considered to act as a fecundative agent."

Upon realising the spirit in which the author has written this book, one is not surprised to find within its pages a graceful note of appreciation to two most valuable helpers. One is Mr. W. W. Eakin, of the Kwa Ibo Mission, and the other Etubom Nyung Ansa, better known by his English name, Chief Daniel Henshaw, Native Political Agent for the district. "He is," writes the author, "a Chief of pure blood and head of one of the seven ruling families of Calabar, where his ancestors were found in possession on the coming of the early traders."

Although Mr. Amaury Talbot fully realises the vast amount of work still to be accomplished in this part of West Africa, he is not discouraged; for he has an interesting theory regarding the solution of the problems before the administrators. "The darker aspects of many rites and beliefs may be attributed," he says, "in great part at least, to the shadow cast over the minds of the people by that dense tropical forest which covers such vast stretches of the West Coast, or by the mangrove swamps which surround low-lying lands. In open sun-lit country, like the wide plains of Northern Nigeria and the Sudan, the more revolting customs seem to be dying out, as was the case in Egypt with the cutting of the bush, and in Europe with the thinning of the great forests."

Climatology, Objective and Subjective.

(1) *Die Klimate der Erde: Grundriss der Klimakunde.* Von Prof. Dr. W. Köppen. Pp. x+369+8 Tafeln. (Berlin und Leipzig: Walter de Gruyter und Co., 1923.) *7s. 2d.*

(2) *Die geopsychischen Erscheinungen: Wetter und Klima, Boden und Landschaft in ihrem Einfluss auf das Seelenleben.* Dargestellt von Prof. Dr. Willy Hellpach. Dritte, neubearbeitete Auflage. Pp. xx+531. (Leipzig: Wilhelm Engelmann, 1923.) *14s.*

DEEPLY rooted in the human mind is the instinct to collect "specimens," to classify them and to arrange them in museums. Prof. Köppen is the exponent of this instinct in the domain of climatology; his specimens are data of temperature and rainfall. Some years ago he laid down his system of classification, and now he has completed and arranged his collection. "The Climates of the Earth" (1) is a handbook and guide to the Museum of Climatology. After a general introduction dealing along the usual lines with the objects and methods of the study of climate and the factors which govern the distribution of the climatic elements, we have a full account of the system of classification and notation, followed by generalised and then by more local descriptions of the different types. Finally there are sixty-nine pages of "specimens," namely, the mean and extreme temperatures, the rainfall, and in some cases the cloudiness and humidity for more than a thousand stations.

The results of such a systematic treatment are not difficult to foresee. There is an orderly development of the subject-matter which effects great economy of space. The ordinary political boundaries are ignored; Asia, for example, is treated under four headings, the tropical rain-belt, the dry region, the warm temperate rain area, and the boreal zone. The description is logically complete, and yet occupies only twenty-one pages. There is an even greater triumph of system in the frontispiece map, from which, knowing the notation, it is possible to read off the salient features of the climate of any part of the world with great ease and definiteness. On the other hand, when everything is subordinated to a system, there is no room for details which from the author's point of view are irrelevant. Climatic peculiarities which the visitor might regard as of some importance, such as the mistral of the Mediterranean, are either ignored or dismissed in a brief and colourless sentence. The use of the shorthand notation accentuates this impression of flatness; the statement that the climate of a large region is *Cfb* is no doubt complete and accurate, but until the interpretation becomes automatic, it is irritating

rather than inspiring, especially to the non-German reader who has to deal with contractions in a language not his own.

To sum up, the book gives a clear insight into the causes underlying the distribution of the main climatic features over the globe, and for this reason should be of great value to teachers, who can make use of the excellent arrangement of the material while filling in the details from other sources. The statistician will welcome it for the amount of information it conveys in a small space, but the ordinary reader will find it rather devoid of human interest and picturesque illustration. The author certainly has the courage of his convictions, for while there is a very complete index to the tables, except for the table of contents at the beginning there is no index to the text.

(2) "Geopsychical Phenomena" is a book of a very different stamp. The author is a nerve specialist, whose interest lies in the reaction of man to his natural environment, and from his medical experience he is able to write with great authority on the mechanism of these reactions. For him the basis of a classification of climates is not the mean temperature and rainfall, but the influence on human well-being, especially as exerted through the mind, either by means of the senses or by the general level of health induced. Climates (and also temporary weather conditions) are classed as enervating or bracing, and the instrument of research is not the thermometer or rain-gauge but the "weather man," who experiences these effects to the greatest degree. Thus the book is almost entirely subjective; it is of great human interest, as is proved by its having reached a third edition.

The chief sources of this interest are the vigorous detail and the fact that most of us have experienced in a greater or less degree the feelings described, for example, as accompanying the passage of a thunderstorm. But there is often a lack of definiteness, partly due to the subject-matter, which does not lend itself to exact treatment, and partly because the weather elements which the author regards as most important are not always those about which climatologists have most to tell us. Atmospheric electricity is credited with great effects, while the powers of solar radiation of various wave-lengths are well known, but more data about the distribution of these elements are required before the subject can be treated definitely. Hence the author is not entirely unjustified in blaming meteorologists for a certain inconclusiveness in some of his remarks. An experiment of even greater difficulty and, if possible, of even greater interest, is the attempt to measure the effects of that branch of the environment termed the landscape. The analysis mainly consists of a study of colour and form, and is certainly justified by its importance, but at the present stage a definite measure of the health-value of a landscape is scarcely to be expected.

It is interesting to note that even in such a subject as the "feel" of weather, numerical methods have obtained a foothold. Thus several formulæ are quoted which express the sultriness of the air numerically in terms of the temperature and humidity. None of them is quite successful, but they constitute a beginning. The author does not appear to be acquainted with recent British work on this and allied subjects, owing to difficulty in obtaining the necessary journals.

The book should be of great value to doctors, of interest to meteorologists and geographers, and it has also a strong appeal to the general reader, but only those who read German readily should attempt it. Once again we have to bewail the absence of an alphabetical index, and this time the omission is more serious.

The Teaching of Mathematics in France.

(1) *Cours complet de mathématiques spéciales.* Par Prof. J. Haag. Tome 3 : Mécanique. Pp. viii + 190. (Paris : Gauthier-Villars et Cie, 1922.) 12 francs.

(2) *La Composition de mathématiques dans l'examen d'admission à l'École Polytechnique de* 1901 *à* 1921 Par F. Michel et M. Potron. Pp. xii + 452. (Paris : Gauthier-Villars et Cie, 1922.) 40 francs.

(3) *Dynamique des solides.* Par Dr. J. Reveille. (Encyclopédie de Mécanique appliquée.) Pp. 506 (Paris : J.-B. Baillière et fils, 1923.) 40 francs.

MATHEMATICAL teaching in Great Britain, at least in its more elementary stages, makes its appeal to the intuitive faculties of the pupil, and the mathematical and mechanical principles and methods are made as real and immediate as possible. If Prof. Haag's treatises are representative samples of French mathematical text-books, then they indicate that French mathematical teaching aims more at capturing the imagination of the learner and exercising his reasoning faculties in abstract terms. The professor's aim is to provide books for candidates who wish to enter the famous École Polytechnique and the École Normale Supérieure in Paris, and thus the book caters for the better class of pupils from the lycées or secondary schools. The atmosphere of the present book (1), with its emphasis on mechanical principles, is nevertheless highly abstract and theoretical. The treatment is interesting and possesses the elegance we expect from French writers. The author claims that "Un livre de mathématiques ne doit pas se lire comme un roman ; plus il exige de travail et de

réflexion plus il est profitable." An English schoolboy would almost certainly read such a book like a novel, especially as in this "Cours" the examples are relegated to separate volumes. The author emphasises the importance of the examples and insists that the student should do a considerable number himself. French pupils can no doubt use such books: the English pupil needs something more concrete—but it would do any English student a considerable amount of good to read Prof. Haag's volume on mechanics, and study his interesting account of the principles of the subject.

This abstract and theoretical character is also to be found in the collection of mathematical questions set at the entrance examinations to the École Polytechnique, and issued with solutions by MM. Michel and Potron (2). The subjects included are algebra with analysis (*i.e.* calculus), trigonometry, geometry, and mechanics. Numerical examples are very rare, being limited apparently to the actual solution of equations. Even the questions on mechanics are very abstract and bear little relation to life, but they seem to test very well the fundamental principles. In each question the examiners suggest a topic or a mode of treatment, with a number of applications: the candidate's duty is to apply his knowledge to the series of questions on this one topic or method. We quote as an illustration *one* "composition" under the caption: Analytical Geometry and Mechanics.

I. On the logarithmic spiral $r=ae^{m\theta}$ take M_0, M defined by θ_0, θ.

(1) Find the centre of gravity G of the arc M_0M.
(2) Find the limiting position of G as M_0 tends towards the pole O.

II. When M_0 is at O, let the polar angle θ of M increase at the rate of 1 radian per second.

(1) Investigate the curve Γ which is the locus of G.
(2) Find completely the velocity V and acceleration A of G for any value of θ.

III. Instead of the spiral consider any curve C. The end of the arc $M_0M(=l)$ of this curve is supposed to move along C according to some given law in terms of the time. Given the centre of gravity G of the arc M_0M, the end M of the arc, the tangent MT at M, the length l of M_0M, the first two differential coefficients (l', l'') of l with respect to the time, find completely

(1) The velocity V of G.
(2) The acceleration A of G.

IV. In the particular case when the curve C consists of two rectilinear segments M_0O, OM

(1) Find the centre of gravity G of M_0M.
(2) Find the locus Γ of G as the segment OM assumes all possible positions round O as a pivot in the given plane.

This should be sufficient to indicate the style of the questions. The solutions are interesting and occasionally elegant.

(3) Dr. Reveille's book is a compromise between the abstract and the practical, as befits a volume forming part of the "Encyclopédie de Mécanique appliquée" issued under the direction of Prof. Lecornu. It combines in a really competent manner the theoretical and the industrial aspects of the subject of rigid dynamics. There is a good account of the motion of a body about a fixed axis, of general two-dimensional rigid dynamics, of the motion of a rigid body about a fixed point including both the Poinsot construction and the elliptic function solution, of the top, of a rigid body on a plane, and of the theory of gyroscopic motion. The whole forms a very good account of the most useful and important parts of rigid dynamics, including the method of Lagrange's Equations applied to holonomic and non-holonomic systems. At the same time the author discusses in considerable detail a large number of practical applications, such as the motion of millstones, the treadmill, the hoop, the bicycle, including looping the loop, and all kinds of gyroscopic methods, such as Foucault's experiment, Brennan's monorail, the motion of torpedoes, and various forms of gyroscopic compasses.

S. BRODETSKY.

Ambroise Paré.

Selections from the Works of Ambroise Paré. With Short Biography and Explanatory and Bibliographical Notes, by Dorothea Waley Singer. (Medical Classics Series.) Pp. iv+246. (London: J. Bale, Sons and Danielsson, Ltd., 1924.) 12*s.* 6*d.* net.

AMBROISE PARÉ (1510 ?–1590), although brought up as a barber surgeon, lived to become the founder of French surgery, one of its shining lights, and one of the greatest military surgeons of all time. He published a great deal during his lifetime, and his collected works appeared in many editions after his death. There must have been a very large number of copies of his works, and yet the earlier ones are excessively rare or even unobtainable in some of the largest medical libraries. Paré's experiences were bought practically in numerous campaigns, battles, and sieges in which he served various French kings against that stormy petrel of the sixteenth century, Charles V. Apart from his practical skill as a surgeon, Paré's name has been honoured in all subsequent ages as the ideal of an honest, modest man of a most humane disposition,

with an intense feeling of sympathy for the wounded soldier gashed by gunshot wounds or arrow-heads. His modesty is summed up in his motto, "Je le pansay et Dieu le guarit."

After the exhaustive work of Malgaigne and the charming work of Stephen Paget it is difficult to give a new view of Paré which is equal to theirs. Mrs. Singer set herself a difficult task, and in our judgment she has not been altogether successful. Her book consists of an introduction of 46 pages, in which the main facts of Paré's life and work are set out, while the rest of the book is a reprint of the English translation which Thomas Johnson made in 1634 from the Latin translation of Paré's "Œuvres" in 1582, by Paré's pupil Jacques Guillemeau. A comparison of the original French with Johnson's translation shows that Paré lost somewhat in his English garb, and it would probably have been better to replace the archaic Johnsonian phraseology by a modern English translation of the sections quoted.

A work like that which Mrs. Singer has attempted really requires co-operative editing in the present state of knowledge. A typical example may suffice. With reference to a case, described and cured by Paré, of a certain Guordon, Seigneur d'Achindon, Mrs. Singer gives a footnote (p. 68) which is almost certainly incorrect. She has been unable, she says, to trace Achindon, but there is no difficulty about this, as Auchindoun was the stronghold of the Huntly family, and still exists as a well-known ruin near Dufftown, N.B. The Guordon of Paré was almost certainly not the person suggested in Mrs. Singer's footnote, but Sir Adam Gordon of Auchindoun—the "Edom of Gordon" of Scottish ballad fame. This gay Gordon, after various adventures at Corrichie and elsewhere, burned the lady of Towie in her castle in 1574 and fled to France, where he was pursued by one of her kinsmen, Arthur Forbes. A most circumstantial account of Forbes's attempt to assassinate Auchindoun will be found in Robert Gordon's "History of the Earldom of Sutherland," 1830, p. 170, and this agrees exactly with the account of the Seigneur d'Achindon of Ambroise Paré. The matter we have referred to is perhaps trivial, but in works on medical history it is well to be accurate.

Our Bookshelf.

The Moon-Element: an Introduction to the Wonders of Selenium. By Dr. E. E. Fournier d'Albe. Pp. 166+8 plates. (London: T. Fisher Unwin, Ltd., 1924.) 10*s.* 6*d.* net.

Dr. Fournier d'Albe's book is chiefly a history of the optophone, the instrument for enabling the blind to read ordinary print. This history claims about one-third of the volume and deals in chronological order with the development of the device from its invention by Dr. Fournier in 1913 to its present form in which Messrs. Barr and Stroud, and, in particular, Dr. Archibald Barr of that firm, have collaborated. The long eighth chapter is a record of the pertinacity of the author for many years in the face of discouragement and opposition, and is almost a biography. Indeed, a not unsuitable title for the chapter, if not for the whole book, might be "The Triumph of the Optophone." It is natural enough that an author should write at length on the fruit of his own efforts. Here, in so small a volume, the effect has been to curtail too much what could have been written about other important applications of selenium. The optophone is the only instrument described in anything like detail. Most of the other selenium devices are referred to only briefly, and a few get no mention at all.

Dr. Fournier is not afraid to speculate; he does so whole-heartedly in more than one place. In the first chapter entitled "Electricity and Light," he gives himself especially free rein when he pictures "the two kinds of electricity as consisting of living beings of sub-atomic dimensions, divided, like the higher animalcules, into two sexes, and living their life on a scale of time and space removed a millionfold from the latter." The inclusion of this first chapter, much of which bears little relation to the scientific treatment of the subject in hand, definitely marks the book as popular rather than technical. Perhaps, indeed, this has been the purpose of the author, although it is not so defined in the preface. His enthusiasm for his subject sometimes displaces the impartiality proper to scientific description, and he would probably be prepared now to admit that his hypothetical and comprehensive condemnation of all selenium cells, save those of his own construction, as expressed in line 24, page 70, is scarcely worthy of an investigator of his own attainments.

In spite of its scientific defects the book is most eminently readable. Dr. Fournier's wide experience as an author in varied fields is a guarantee of that. He has a way with him in writing that grips the reader; the reviewer himself read the book from cover to cover in a single sitting. Dr. Fournier writes with the authority of a recognised expert, and if, as the title rather suggests, he has aimed at arousing the spirit of wondering interest among the general public, he will without doubt succeed. A. O. R.

Pulpwood and Wood Pulp in North America. By R. S. Kellogg. Pp. xii+273. (London: McGraw-Hill Publishing Co., Ltd., 1923.) 20*s.*

The manufacture of paper from wood pulp began on a commercial scale in 1854, as before that date the raw material ordinarily used was cotton and linen rags, esparto grass, straw, and hemp. The first process of making paper from timber was a purely mechanical one, by which the fibres of the wood, after being torn apart by grindstones under a stream of water, were transformed into so-called "mechanical" pulp, which is still the source of the cheaper kinds of paper. Tilghman in 1867 discovered the disintegrating action of sulphurous acid upon wood; and this formed the basis of the invention of the sulphite process, which was started commercially in Sweden

in 1874. The resulting product, "chemical" wood pulp, is used for the better classes of paper.

The wood pulp industry in a little more than half a century has grown to an enormous extent in Scandinavia, Germany, and North America. This is not to be wondered at, as the consumption of paper is increasing all over the world by leaps and bounds. In 1922 the paper used in the United States for newspapers alone amounted to 45 lb. per head of the population.

Mr. Kellogg gives a detailed account of the pulp industry as it is now carried on in Canada and in the United States. He describes the various processes of manufacture and the different species of woods employed, and gives statistics and charts of costs and production. He deals very fully with the important question of the timber supply now available in North America; and discusses the annual drain on the forests, due to felling for all purposes and loss by fire, insects, and disease. It is estimated that the timber in the United States at the present rate of consumption will last only for sixty-four years. The need for scientific forestry and better modes of protection is urgent in the extreme. The book is well illustrated with diagrams, maps, and reproductions of photographs, which depict forest scenes, pulp mills, and machinery. The view of a nursery in Canada, where five million seedling trees are raised annually, shows that some of the great lumber companies are at last taking active measures to replenish the areas that have been devastated by reckless felling and disastrous fires.

An Introduction to the Theory of Optics. By Sir Arthur Schuster. Third edition, revised and enlarged by the Author and Prof. John William Nicholson. Pp. xv+397. (London: E. Arnold and Co., 1924.) 18*s.* net.

THERE is no need to set out here the merits of Sir Arthur Schuster's book on optics, and in describing the new edition, in which he has had the collaboration of Dr. J. W. Nicholson, we may confine ourselves to the novelties that have been introduced. These include descriptions of some of the newer optical instruments and processes, among them an excellent account of Michelson's method of measuring stellar diameters.

The main addition is in two chapters at the end, which deal with the quantum theory. In the first of them there is a good account of Bohr's theory of the hydrogen spectrum, which is followed by a short discussion of Planck's law of radiation. In this there is an unfortunate misprint, giving preference to Planck's second hypothesis over his first, instead of the other way about. We may also regret the absence of any mention of the thermodynamic principles which should serve as the basis of any discussion of radiation; indeed a detailed discussion of "black body radiation" would be a proper complement to the excellent descriptions of white light that are found earlier in the book. The account of the partition law is adequate, though we may confess a doubt whether a student coming fresh to the subject would find it convincing. However, this objection applies to nearly all presentations of the subject which approach it without a thorough consideration of statistical principles.

The last chapter deals with the dynamical theory of spectra. It follows mainly the work of Sommerfeld and his school, giving the three dimensional quantisation, fine structure, etc., and then Sommerfeld's construction of the formulæ of Rydberg and Ritz. It also contains an account of ionisation potentials and concludes with the dynamical theory of the separation of variables, the principle of adiabatic invariance and the correspondence principle which is applied to the Stark effect. Altogether the whole constitutes a good outline of many of the more recent optical applications of the quantum theory.

James Dewar, 1842–1923: a Friday Evening Lecture to the Members of the Royal Institution, on January 18, 1924. By Henry E. Armstrong. Pp. 32. (London: Ernest Benn, Ltd., 1924.) 1*s.* 6*d.* net.

EULOGY, whether spoken or written, makes greater demands upon judgment, knowledge, and taste than any literary task—so difficult is it, while maintaining equipoise between the elements that compose virility and virtue, to avoid transgression into adulation too fervid or into praise too faint. When eulogy relates, however, to a friend who has passed beyond mortal life, the task is to some writers made easier, for thoughts then spring from the depths in proverbial abundance, and there is more of reverence to steady the balance. It is in these circumstances that Prof. Armstrong pays tribute to his friend James Dewar. He extols the great philosopher in terms the substance of which is already familiar to those who early in the year followed the proceedings of the Royal Institution; but it is well that the discourse then so finely wrought in the rough, and now polished, and set in the gold of generous appreciation, should take this permanent form. Here and there some comparisons may be too vivid, here and there the detail may be weak, and the allusions may occasionally be inconsequent and in excess, but the work as a whole reveals with truth and justice the skill, genius, character, and nobility of purpose of James Dewar, in a manner to encourage and to inspire all who study it in a mood to respond. R. A.

Assyrian Medical Texts: from the Originals in the British Museum. By R. Campbell Thompson. Pp. vii+107. (London: Oxford University Press, 1923.) 42*s.* net.

IN our issue of April 12, p. 529, we published a note on a reprint from the Proceedings of the Royal Society of Medicine by the same author on the same subject. The present work is a series of 107 plates containing the text of 660 cuneiform medical tablets for the most part previously unpublished. They are from the Royal Library of Ashurbanipal, now preserved in the British Museum, and date from the seventh century B.C. It is perhaps to be regretted that the preface is not given in greater detail, as otherwise the work is intelligible only to Assyriologists.

Bell's Card of Logarithms and Science Tables 10 in. × 8½ in. (London: G. Bell and Sons, Ltd., 1924.) 2*s.* net per dozen.

THIS is a single card of convenient size for use in classrooms, giving four figure logarithms, trigonometrical tables for intervals of one degree, and a number of useful physical and chemical constants.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Liquid Crystals—Soap Solutions and X-rays.

AMONGST the earliest examples of Lehmann's liquid crystals were the transparent double cones of ammonium oleate. MacLennan's work has shown that this transparent anisotropic state is common in soap solutions. The accompanying photograph (Fig. 1), taken by Mr. W. J. Elford in this laboratory at the suggestion of my colleague Mr. Piper and myself, shows the very striking appearance presented by these transparent solutions when examined in slightly convergent light between crossed Nicols. The transparent conic anisotropic liquid shown occurs in 2·5 weight normal potassium laurate at 45° C., magnification 200 diameters, and it exhibits very clearly the characteristic fan-like structure composed of focal lines.

A glance at the photograph shows the aptness of

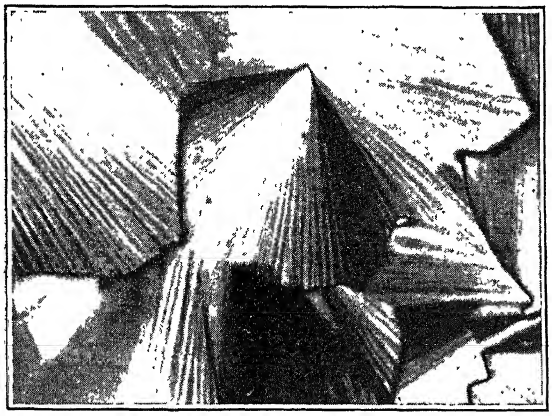


FIG. 1—2.5 N potassium laurate. Transparent anisotropic plastic phase (40-50° C.). × 200 diameters.

Friedel's designation of this state of matter, namely, "liquide à conique," which he now proposes to supersede by the term smegmatic (smectique) in order to place soap curds in this class. We have found, however, that every aqueous soap such as potassium laurate may be prepared in each of the forms: hexagonal crystals, curd fibres, and anisotropic and isotropic liquids.

Piper and Grindley found a year ago that the curd fibres show an X-ray structure resembling Müller and Shearer's X-ray diagrams for crystals of fatty acid, whereas anisotropic liquids have given negative results. Following Friedel, they ascribed these curds to the "smegmatic condition." Friedel nevertheless expressly states that for any substance there can be only one "smegmatic" form, and that there are no discontinuities in a "smegmatic" specimen other than the apparent focal lines. Now curd fibres are discrete, and they differ greatly in almost every way from the conic anisotropic liquid soap illustrated in the accompanying photograph, which is seen to typify Friedel's "état smectique" or "liquide à conique." It is therefore evident that Friedel's attempt to classify opaque soap curds as "smegmatic" when that state is already filled by the transparent conic liquid soaps would disrupt his classification of liquid crystals and necessitate the *ad hoc* setting up of a new group within which to include such curds.

JAMES W. MCBAIN.

University of Bristol.

Earth Tides and Ocean Tides.

I AM in entire sympathy with Mr. Lambert's plea in NATURE of June 21, p. 889, for further research on earth tides. It is much to be regretted that so little has hitherto been effected in that direction. I only wish our "far-flung" Empire had done its share in investigating geophysical problems connected with the earth's crust. I fancy, however, that the horizontal pendulum would be more easily and cheaply installed in outlying stations than the interferometer apparatus of Michelson and Gale. The Milne-Shaw seismometer can be adapted for the purpose by the addition of a stationary mirror tracing a reference line on the record.

Mr. Lambert refers to the "greater apparent rigidity in the prime vertical than in the meridian . . . in various places near the Baltic Sea." This presumably applies to the horizontal pendulum observations at Potsdam and Dorpat (in Esthonia). He goes on to say that "when various ingenious explanations of this peculiarity were found to be untenable, it came finally to be accepted that the true explanation lay in the effect of the oceanic tides."

At Potsdam, where the inequality of the rigidity in different directions is much greater than at Dorpat, the direction of maximum rigidity is apparently not due east and west but about 8° north of west and south of east. This is approximately parallel to the strike of the later foldings in the older rocks to the south and no doubt also of those covered by the Quaternary deposits in the neighbourhood of Potsdam itself. This folding probably extends some miles down in the earth's crust and must diminish the rigidity in a direction at right angles to its strike. I fail to see why this explanation is untenable.

It would be interesting to ascertain how rigidity varies with direction in the neighbourhood of lines of north and south folding.

JOHN W. EVANS.

Imperial College of Science and Technology,
S. Kensington, S.W.7.
June 28.

The Structure of Molecules in relation to their Optical Anisotropy.

As is well known, the light scattered transversely when traversing a column of gas or vapour is not completely polarised, the defect of polarisation depending on the nature of the substance. The explanation of this phenomenon as developed by the late Lord Rayleigh, Born, Sir J. J. Thomson and others is that the molecules which scatter the light are optically anisotropic, that is, have different refractivities in different directions, and are oriented arbitrarily in space. From the point of view of dispersion-theory, the interpretation usually given is that the electrons responsible for the refraction of light are anisotropically bound in the molecule.

This way of regarding the matter, though perhaps not formally incorrect, does not hold out much hope of progress in interpreting the experimental results, owing to the scantiness of our knowledge regarding the manner in which the dispersion-electrons are bound in complex molecules. Recently, under the writer's direction, a series of accurate measurements have been made in his laboratory of the scattering of light in some thirty different gases and vapours by Mr A. S. Ganesan, and in more than sixty different transparent liquids (chiefly organic compounds) by Mr. S. Krishnan, and the empirical knowledge thus accumulated of the relation between light-scattering and chemical constitution emphasised the unsatisfactoriness of the position of the subject on the theoretical side. Thus,

for example, the observations showed that molecules containing elongated chains of CH_2 groups and therefore highly unsymmetrical in shape are, optically, much more nearly *isotropic* than benzene, toluene and other compounds of the aromatic series

These and other results stand in need of explanation, and it is the purpose of this note briefly to indicate a method of dealing with the matter which is at least a useful working hypothesis. The suggestion is that the optical anisotropy of the molecule is due, in the main, to the mutual influence of the electric doublets induced by the external field in its constituent atoms, the latter, individually, being themselves more or less completely isotropic. A similar idea has recently been used very successfully by W. L. Bragg to explain the doubly-refractive character of substances in the solid crystalline state, *e.g.* calcite and aragonite.

Following up the working hypothesis indicated, Dr. K. R. Ramanathan has, at the suggestion of the writer, calculated the degree of optical anisotropy to be expected theoretically for the molecules of a number of substances in the gaseous state and obtained most encouraging results. The fullest test of the theory will be that furnished by the series of organic vapours studied; the detailed calculations necessary for this purpose have been undertaken. Qualitatively, it is not difficult to see that the closer packing of the atoms in the benzene rings compared with that in the chain compounds would enhance their mutual influence, and that, consequently, the greater anisotropy exhibited by the compounds of the aromatic series is what we should expect on the hypothesis suggested. C. V. RAMAN.

s.s. *Kaisar-i-Hind*, near Marseilles,
June 19.

Emission of Volcanic Gases.

I TOO have been shown the effect described by Prof. Conway in NATURE of June 21, p. 891, at the Solfatara, near Naples. I was inclined to believe in its objective reality, but was not sure. I write to suggest that some scientific man who is taking his holiday in that neighbourhood should carry a camera with him, and obtain a photograph before, and another after, the torch has been applied to the vent. In that way I think it would be easy to decide objectively whether the distant vents are affected or not. RAYLEIGH.

69 Cadogan Square, S W 1, June 21.

I WAS glad to see Prof Conway's letter on the "Emission of Volcanic Gases" in NATURE of June 21, in which he directs attention to the remarkable phenomenon observed at the volcano of Solfatara when a lighted torch is waved over one of the vent-holes in the crater.

I was also present at Naples on the occasion mentioned, and, along with some friends, took the opportunity of visiting Solfatara, where we observed the phenomenon described by Prof. Conway.

The increase in the amount of fumes emitted was quite unmistakable. A A. ROBB.

Cambridge, June 22.

I HAVE seen repeatedly during the last thirty-eight years the evocation of gas at Solfatara, described by Prof Conway in NATURE of June 21, p. 891. The phenomenon is certainly not subjective, neither is it trickery. I venture to offer the hypothesis that, under the floor of the crater, deep caverns are filled with volcanic gases, the equilibrium of which is unstable to a small change in atmospheric pressure, such a change being effected when the air above a group of crevices is heated by the torch. The crevices must be connected with the deep reservoir by passages, and the gas must be generated into the reservoir at a pressure exceeding atmospheric pressure by the pressure due to the vertical column of heavy gas in the passages, added to the pressure necessary to produce the flow of the gas through their length.

Instability is due to the fact that gas drawn up to the torch is hot gas, which therefore rarefies the air more, and so draws up more and hotter gas, and further, that the torch drawing gas from the passages to the crevice must draw also gas from the deep reservoir to the passages and from the lower part of the passages to their upper part In all cases the gas passes from deeper and therefore hotter strata to higher and therefore cooler strata—so that the whole gaseous column becomes warmer and therefore lighter than it was before. Consequently the weight of the column no longer equipoises the pressure in the deep reservoir, and this therefore forces out gas by the passages through every aperture, the uprush further heating and lightening the column, and therefore renewing itself, until a second equilibrium is reached at a lower reservoir pressure plus a more rapid upward flow of gas. Eventual slackening of this flow and reversal of the steps must be brought about by the cooling of the deep chambers producing a lower pressure of generation, this reduces the rate of flow and therefore increases the time which is passed by the column in the cooler strata. The column therefore becomes cooler and heavier and requires higher pressure in the reservoir to lift it, while the escaping gas is cooler and the rarefaction of the external air lessens Each consequence reinforces its cause, until the *status quo ante* is reached with the external atmosphere at its original temperature and pressure.

Evidence for the existence of large unstable gaseous reservoirs has lately appeared to me to concern not only the colliery engineer, but also the biologist It seems possible that some of H. Munro Fox's interesting lunar cycles in life-histories, especially of marine organisms,[1] might conceivably be explained by the earth-wave of spring-tides distorting the walls of subterranean caverns filled with gas, and so releasing an importantly greater quantity of carbon dioxide, etc.; at the new and full moon Thus the constitution of the sea-water in their neighbourhood would have a fortnightly and monthly chemical periodicity which would produce a physiological periodicity in inhabitants sensitive to those constituents.

GEO. P. BIDDER.

Cambridge, June 22

PROF. CONWAY'S letter in NATURE of June 21 again directs attention to this remarkable phenomenon. Since my former visit, my daughter, Ruth Place, has visited the volcano for further investigation, and we suggest that the sudden emanation of visible gases and vapours may be the effect of ionisation started by the torch flame.

There may be another explanation. The whole system must be charged with superheated aqueous vapour, the temperature varying from 99° C to 161° C., as observed by Prof. Mercalli, the lower temperature obviously that taken near the surface. When the organic substance, namely, resin torch, or even a bunch of brushwood, paper, etc., is burnt, it will produce water which will condense the hot aqueous vapour and form fog, and so will quickly influence the whole zone and become visible over an extensive range of ground. JOHN PLACE.

16 The Avenue, Beckenham, Kent.
June 30.

[1] At Naples *Nereis dumerilii* and *Dictyota dichotoma*, both breeding fortnightly (Proc. Roy Soc, vol 95, p. 544) —Note that there are effervescent hot springs known to bathers in the sea at Bagnoli, near the Solfatara

Explanation of Abnormal Low Voltage Arcs.

IT is well established that arcs in gases or vapours may be maintained at voltages as low as their ionising potentials, or, in cases where cumulative ionisation is possible, as low as their radiating potentials, provided a hot cathode is used as a source of electrons to stimulate the arc Considerable discussion has arisen over certain cases in which arcs have been maintained at still lower voltages,[1] since at such voltages the electrons are known not to effect partial or complete ionisation of molecules with which they collide.

Recently Bar, v. Laue and Meyer [2] and, independently, the present writers,[3] have shown that this may be accounted for by the existence of oscillations the peak voltage of which always exceeds the lowest radiating potential of the gas. An experimental and theoretical study of these oscillations has shown them to be in the nature of current interruptions occasioned by the rise in current and consequent drop in voltage occurring when the ionisation is sufficient to create a positive space charge around the filament. Under such conditions there is nothing to prevent a rise in current to its saturation value. With such a rise, the increased potential drop in the series resistance reduces the voltage across the arc. If this reduction takes the voltage to a value below the lowest critical potential of the gas, the current can be maintained only so long as the supply of previously excited atoms persists, after which the current decreases, the voltage rises, and the cycle is repeated Reactance in the circuit is not, as believed by Bar, v Laue and Meyer, essential to the oscillations, though it does affect the wave form

The above phenomenon does not explain all cases of abnormal low voltage arcs, however, for we have maintained arcs in helium, mercury vapour and argon, without oscillations, at voltages well below the lowest critical voltages of the gases. Also Holst and Osterhuis [4] have reported steady arcs in argon at 3·5 volts and neon at 7·5 volts, whereas the lowest critical potentials of these gases are 11·5 and 16·7 volts respectively To account for this, these authors have proposed a rather elaborate theory of progressive ionisation. The following experiments, however, explain entirely these abnormally low voltages simply on the basis of well-known phenomena

A short hot-filament cathode and a sheet nickel anode were placed about 1 cm apart, and a 3 mm. length of 1 mil wire projecting from a glass stem was introduced as an exploring electrode in a bulb filled with pure argon at 2 mm pressure. This electrode was used according to Langmuir's recent method,[5] and was movable to different points in the discharge by a flexible copper-to-glass seal.

It was found that the arc could easily be maintained at an applied voltage of about 4 volts, without oscillations Under these conditions, however, *the gas near the filament was found to be at a potential of about* 11·5 *volts above that of the filament,* and there was an electric field in the direction reverse to the applied field throughout most of the space between the electrodes. Furthermore, the concentration of ions, either positive or negative, was found to decrease from about 100×10^{10} per cc. near the cathode to about 2×10^{10} per cc. near the anode. The average kinetic energy of the electrons outside the region of the cathode drop was found to vary from 2 to 4, in equivalent volts. Analogous results were found in a mercury arc, operating at about 3·5 volts.

Evidently there is *always* a sufficient cathode drop to produce ionisation. If the ionisation is intense, positive as well as negative ions move toward the anode, and at approximately equal rates. To cause this, the reverse electric field, caused by difference in rates of diffusion of electrons and positive ions, takes such a value as to cause the two types of ions to move toward the anode at nearly equal rates. It is easily shown that the number of ions of either sign is at least a million times greater than the excess of one kind over the other, except in the region of the cathode drop

A fuller treatment of this problem and its significance in the Geissler tube discharge will soon be published.

We are indebted to Dr. Irving Langmuir for suggesting this general line of explanation of the abnormal arc.

KARL T COMPTON.
CARL H. ECKART.

Princeton University

[1] Compton, Lilly and Olmstead, *Phys. Rev*, 4, p. 282, 1920, A. C. Davies, Proc Roy Soc, A, 100, p 599, 1922.
[2] *Zeits f Phys.* 20, p 83, 1923
[3] *Science*, 59, p. 166, 1923.
[4] *Physica*, 4, p 42, 1924.
[5] *Gen. Elec Rev.*, p. 731, Nov. 1923.

De Broglie's Theory of the Quantum and the Doppler Principle.

L. DE BROGLIE (*Phil. Mag.*, Feb. 1924) has recently suggested a theory of the quantum in which the quantum is supposed to be a corpuscle of exceedingly small rest mass M which moves with a velocity βc, where β is less than unity by an exceedingly small amount. The momentum of such a corpuscle is $M\beta c/\sqrt{1-\beta^2}$, and is equal to that of the light quantum $h\nu/c$ Since β is so nearly unity, the momentum may be written as $Mc/\sqrt{1-\beta^2}$. Different values of the frequency ν are explained as being due to different values of β.

Let us suppose that an atom is moving towards the observer with a velocity $\beta_1 c$, and that while moving with this velocity the atom ejects a quantum in the direction of the observer, the frequency of the quantum being ν_0 and its velocity $\beta_0 c$ relative to an observer on the atom. The momentum of the quantum relative to the atom is then $h\nu_0/c = Mc/\sqrt{1-\beta_0^2}$. By applying the relativity theorem of the addition of velocities, we have that, if βc is the velocity of the quantum corpuscle relative to the stationary observer,

$$\beta c = (\beta_0 + \beta_1)c/(1+\beta_0\beta_1).$$

Hence
$$1-\beta^2 = \frac{(1-\beta_0^2)(1-\beta_1^2)}{(1+\beta_0\beta_1)^2}.$$

Remembering that β_0 very nearly equals unity, and assuming that β_1 is small, we have

$$1-\beta^2 = (1-\beta_0^2)(1-\beta_1)^2.$$

Hence if ν is the frequency relative to the stationary observer we have

$$h\nu/c = Mc/\sqrt{1-\beta^2} = Mc/(1-\beta_1)\sqrt{1-\beta_0^2} = h\nu_0/c(1-\beta_1).$$

If now we put $\beta_1 = v/c$, where v is the velocity of the atom relative to the stationary observer, we have

$$\nu = \nu_0 c/(c-v),$$

which is the equation expressing the Doppler principle when the velocity v of the radiating atom is small compared with c.

G. E. M. JAUNCEY.
Washington University,
St Louis, Mo, May 23.

THE result obtained by Mr. Jauncey seems to be quite correct, and I already knew that it was possible to explain all the forms of Doppler effect by means of my "light quantum" conception.

By studying the collision of a moving electron with a light quantum, I have also obtained a formula for the change of frequency which involves both the Doppler effect and the Compton effect.

In a recent number of the *Phil. Mag.* (May 1924) Mr. William Anderson has stated a curious and perhaps not very probable consequence of my views.

I think that the *isolated* quantum of radiant energy can only be considered in radiations of very high frequency (when Wien's law is valuable), but that for radiations of mean or low frequencies we must conceive a sort of aggregation of light quanta. This idea suggested by the form of Planck's law would perhaps allow us to imagine a transition between light quanta and electromagnetic theory and to avoid Mr. Anderson's conclusion.

LOUIS DE BROGLIE

June 14.

Cell Inclusions in the Gametogenesis of Scorpions.

SINCE last winter I have been engaged on the study of cell-inclusions in the gametogenesis of scorpions, and it was, therefore, with some interest that I read the note of Profs. D. R. Bhattacharya and J. B. Gatenby on the spermatogenesis of an Indian scorpion (Palamnæus) published in NATURE, June 14.

I have studied mitochondria in the spermatogenesis of *Palamnæus fulvipes madraspatensis*, and can confirm the following statements of the writers:

(1) "The mitochondria are sorted out whole during the maturation stages" This is true of both the meiotic divisions.

(2) "The number of mitochondria varies in the spermatid."

In *Palamnæus fulvipes madraspatensis* the number varies from four to thirteen.

I am, however, unable to support the statement that "the mitochondria form the sperm tail directly. . . ." During a certain stage in spermateleosis the mitochondria are grouped together at the base of the elongated nucleus. To a large extent they lose their individuality and form a curious oval body—the mitosome—which stains characteristically with crystal violet, Altman's acid fuchsin and iron hæmatoxylin. I have not been able to detect the mitochondria after this stage. Nor have I seen them at any stage descending down the axial filament.

I may here add a note on the mitochondria of the oocyte of the same species. They are remarkably different in their reaction to osmic acid from those of the male germ cells. There is no case on record where the mitochondria are blackened by chrome-osmium alone. Where they are blackened, it is only after prolonged osmication (Kopsch). But the mitochondria in the oocyte are intensely blackened by chrome-osmium alone in ten hours. They are even preserved and blackened by Fleming-with-acetic acid. They can be decolorised by turpentine, but subsequent staining is impossible. They are completely destroyed by Bouin's fluid. These facts undoubtedly suggest the presence of a large amount of unsaturated fat in the mitochondria.

The Golgi apparatus in the oocyte of the same species consists of rods and crescents distributed in patches.

I hope to publish in due course a paper on the cell inclusions in the gametogenesis of Palamnæus (Madras), *Buthus judaicus* and *Heterometrus maurus* (Palestine), and *Euscorpius napoli* (Naples).

VISHWA NATH.

Zoological Laboratory, Cambridge,
June 20.

Art-Forms in Nature.

PERMIT me to thank Mr. Edward Heron-Allen for the very generous reference to my work published in his review of Haeckel's "Kunstformen der Natur" (NATURE, June 14, p. 847). Mr. Heron-Allen says: "A law only approximates to the facts, and every time we use it we have to make appropriate additions and corrections; the real value of deviations is not that they make it necessary to discard a theory, but that they enlarge our laws and thereby advance our knowledge." This sentence formed part of an appreciation of my book, "The Curves of Life," which was published in 1914 With your permission I will quote a short passage from this book which gives an excellent example of the process mentioned, an example which in 1924 we can all read with a startling verification in our minds.

"The principle enunciated by Newton," I wrote on pp. 429 and 430, "may 'simplify' the phenomena of our solar system sufficiently to enable us to talk about the movements of the earth and the celestial bodies. But that simplicity, we may feel sure, is only apparent. Newton himself, as far as I am aware, never ventured to suggest any 'cause' for his great principle. We may well consider that its value as a working hypothesis outweighs the possibilities of its inexactness But we must be equally prepared to realise that it may not fit all the facts which future science may discover. It is, in H. Poincaré's admirable phrase, *une règle d'action qui réussit*, or, in other words, we have added (1914) so few phenomena of real importance to those known by Newton that the basis furnished by his 'law' has not yet been disintegrated. But it is easily conceivable that a broader foundation will be needed, even in the present century; and we need have no fear that men of science will shrink from the endeavour to provide it. The sterile reprobation of Auguste Comte (who was obsessed by sociological ideas of 'Order') has long ago become inoperative."

These lines were written ten years ago, and I freely admit that logic had more to do than special knowledge with a prophecy which Einstein was so soon and so brilliantly to fulfil.

THEODORE A. COOK.

Savile Club, 107 Piccadilly, W.
June 19.

The Oogenesis of Lithobius.

THE oogenesis of the Arthropoda is the least well understood, because it has presented considerable technical difficulties. In this country Hogben has investigated successfully the oogenesis of dragonflies, and has shown that the nucleolus takes important direct part in the production of the yolk spheres.

The oogenesis of Lithobius appears to be much like that of Hogben's examples, and is probably general for Arthropoda. Yolk formation is from nucleolar extrusion, of which two phases can be distinguished; first, an early extrusion of particles budded off from the large central nucleolus, which retains its individuality, and, secondly, an extrusion of particles derived from the fragmentation of this nucleolus. These particles multiply both in the nucleus and in the cytoplasm. The fate of the first nucleolar extrusions has not been determined, but the later extrusions enlarge after proliferation to form the definitive yolk spheres. The Golgi apparatus behaves in the usual way, being excentric and juxta-nuclear in the youngest oocytes, then spreading out through the cell, and breaking eventually into very fine grains. The mitochondria are diffuse in the earliest stages, then become concentrated to a cloud near the nucleus; this breaks up into a number of clusters, some of which become active centres of proliferation. These form curious round mitochondrial bodies, which later fragment, the mitochondria passing out to become evenly distributed through the cytoplasm. The clouds which did not take part in the rapid proliferation also become scattered at the same time.

A full account of the oogenesis will be published later.

S. D. KING.

Zoological Department,
Trinity College, Dublin.

Artificial Daylight.

By Dr. L. C. MARTIN.

THE apparently simple question "What is Daylight?" raises at once a host of supplementary questions which are not easy to answer, and a little consideration shows that "daylight" is a word of somewhat indefinite meaning. The paper on which the present article is being written is illuminated by light from a north window. The sky is blue, but flecked with white clouds reflecting winter sunlight. A proportion of the light is, however, coming from the walls of an opposite house, and since this house is flanked by green trees and shrubs, they are also contributing their share of reflected light. A spectrophotometric examination of the light would doubtless reveal a somewhat irregular spectral distribution of energy, varying from minute to minute, although the eye registers no marked change in the appearance of the paper. Even after the drastic step of drawing the blinds and switching on the electric light, the appearance will scarcely indicate the tremendous alteration in the nature of the light, at any rate when the eye has been accustomed to the changed conditions. It is not until some effect of simultaneous contrast brings the artificial light into comparison with daylight that the difference between the two is revealed.

It is quite clear that it is useless to attempt to copy the heterogeneous radiation described above; therefore it is necessary to study the distribution of energy in the spectrum for summer sunlight and the light from a blue sky, and to see how far the means at present available will allow the production of radiation with similar characteristics. Some suitable compromise can then be decided upon. Fig. 1 shows, reduced to a common ordinate at $0 \cdot 59\mu$, the *relative* distribution of energy in the spectrum for blue-sky light, summer sunlight, and electric light (gas-filled incandescent lamp). The gas-filled lamp radiates, as indicated by experiment, in a manner similar to a perfect radiator (the black body of the physicist) at a temperature of 2800° C. By extrapolating from experimental results, it is found that the sun radiates like a perfect radiator at about 5000° C., a temperature unfortunately quite unattainable at present in any usual and practical terrestrial source of light. It is only in intense electric discharges that such temperatures can be attained experimentally.

Amongst the special means of light production the Moore vacuum tube must be mentioned. The discharge from a small transformer passes through rarefied carbon dioxide at a pressure of about 0·1 mm, the tubes being of considerable length when used for industrial lighting. Luckiesh states that the light is a "good approximation to average daylight." Since the spectrum consists of bands, however, and is by no means continuous, this light is apt to prove untrustworthy for colour matching purposes, more especially in dealing with substances possessing bright narrow bands in the spectrum of their transmitted or reflected light.

Phosphorescence and allied effects are extremely efficient in regard to the energy required in producing a given amount of light, but under present conditions the utilisation of the phenomena for commercial light production is not practicable.

We turn, then, to consider the means of modifying the energy distribution in the spectra of ordinary sources, and before proceeding to the better known methods, two useful laboratory devices may be mentioned. Priest finds that by passing the light through a system of polarising prisms and quartz plates cut perpendicular to the axis, the spectrum of such a source as the gas-filled tungsten lamp can be modified to an equivalent of that from a black body radiating at 5000° C., and moreover, the apparent temperature of the equivalent radiator can be controlled over a wide range. The Arons chromoscope is convenient for the purpose. Another method of interest is the spectrum template of Abney and Ives, in which the radiation from the source is first dispersed

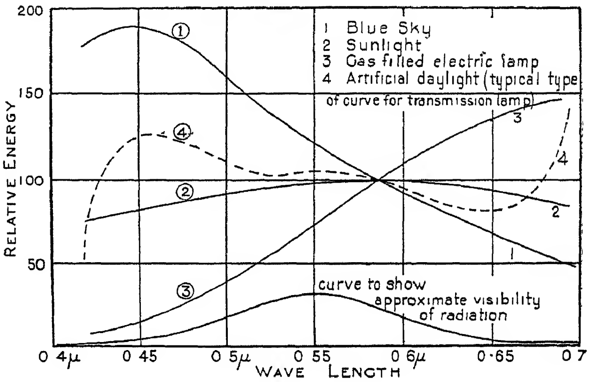


FIG. 1.—Relative distribution of energy in spectra of light sources.

into a spectrum and then recombined. In the plane of the spectrum a sector rotates, and one of the lines bounding the angular opening of the sector is curved in such a way that the effective angular aperture varies so as to be greatest in the blue and least in the red regions of the spectrum. In fact the apparent energy distribution in the spectrum of the reconstituted light can be made to follow any prescribed law.

It will be apparent, however, that the two foregoing methods are wasteful in so far as their action depends on the mere elimination of the excess energy of the longer wave-lengths.

Apart from consideration of energy distribution, however, the two methods above are quite impossible for lighting purposes, and therefore the aid of selectively transmitting or reflecting light filters or reflectors has to be employed, this expedient being suggested by Mr. A. P. Trotter some thirty years ago or so. In 1899 Dufton and Gardner produced a filter for correcting the light from the carbon arc. Though this light has an energy distribution which comes almost as near to sunlight as any artificial light (the temperature of the carbon arc is 3500° C. to 4000° C.), the flame of the arc gives an excess of violet radiation from the well-known cyanogen bands, and hence the radiation needs a special type of correction. Dufton and Gardner's glass was coloured blue-green by means of copper, and a trace of uranium gave the property of filtering out the excess of violet from the arc-light.

Since that time several types of colour filter made of

special glass, or glass in series with dyed gelatin films, have been introduced for the correction of the light from other artificial sources, namely, ordinary metal filament electric lamps, gas-filled electric lamps, and incandescent gas lamps. Lamps employing coloured reflectors have also been introduced. The gas-filled electric lamps work at a higher temperature than those of the ordinary metal filament type, and consequently the correction required to produce artificial sunlight is less drastic in the first case. The correction for an incandescent gas mantle is even less since the spectrum of the radiation is particularly rich in the shorter wave-lengths as compared with the radiation from a "black body" at the same temperature.

On the whole, experience has shown that the gas-filled lamp lends itself most readily to the present purpose, and practically all the modern lamps start with this light mainly because gas-filled lamps can be readily fitted into a lantern or shade without the greater difficulties of ventilation encountered when using an arc or gas burner.

There are at present several varieties of artificial daylight lamps on the market. In the first type the lamp is enclosed in a lantern with a reflector, and the light passes through a colour filter, the glass being coloured by various proportions of cobalt, manganese, nickel, and copper. Suitable glasses have been produced by Ives and Brady, and by Gaze in America. Messrs. Chance Brothers of Birmingham have also produced a "Daylight" glass. The type of correction usually aimed at is a compromise between the energy distribution found in sunlight and blue-sky light; thus the luminous efficiency of such units considered merely as sources of light is inevitably low. In one transmission lamp recently examined by the writer the overall efficiency was only 8 per cent. as compared with the unshaded lamp, but this was employing an ordinary metal filament bulb. If a gas-filled bulb had been employed the efficiency would probably have been much greater, perhaps 12-15 per cent.; a great deal depends on the reflector, which can, if well designed, produce a considerable concentration of light, thereby counteracting the unavoidable disadvantage of the loss of light in the filter.

The glasses employed for the filters often show some deviation from the desirable smooth transmission curve. In the unit due to Lamplough a small excess of green transmitted by one blue filter is compensated by the provision of a second filter of glass slightly coloured purple by the use of gold. The purple filter absorbs the excess of green and the quality of the light is greatly improved.

A second type of lamp (the Sheringham Daylight) employs the device of reflecting the light from a surface coloured with patches of blue, green, and red or yellow pigments in definite proportions of area. The light is completely diffused, and this is a considerable advantage when imitating the effects of actual daylight. Furthermore, the energy distribution of the reflected light can be made very "smooth," although it is difficult, just as before, to secure drastic correction without undue loss of energy. The method of making a spectro-photometric comparison between natural and artificial daylight has been described by Mr. P. R. Ord in the *Illuminating Engineer* for July 1923, but there is at present very little available information on the relative performances in energy distribution and luminous efficiency of the various lamps.

The actual correction attained in all these lamps is good over the brightest part of the visible spectrum between $0{\cdot}45\mu$ and $0{\cdot}65\mu$. At the violet end the radiation is very deficient in violet, and at the extreme red end practically all the commercial units give far too much energy (see Fig. 1). The fact that these defects do not destroy the ordinary usefulness of the lamps is owing solely to the low visibility of the radiations corresponding to extreme ends of the spectrum, as shown by the lowest curve in Fig. 1. Occasionally the error is made manifest by some material with a low reflection through most of the spectrum and a large reflection at the red end. The "artificial daylight" may then produce a different appearance in such a substance as compared with daylight itself, but on the other hand, such materials vary greatly in appearance under the variations of daylight.

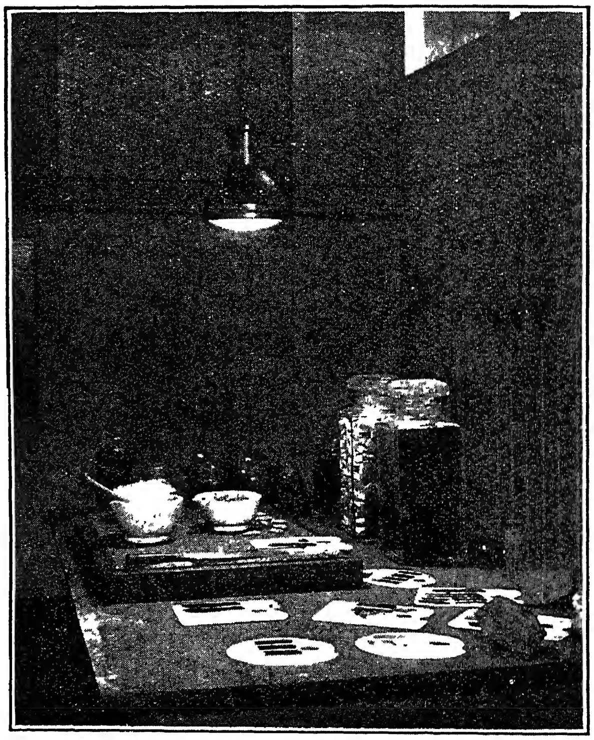


FIG. 2.—Lamplough daylamp (200-watt industrial model) in use at the laboratories of Messrs. Winsor and Newton, Ltd., for grading pigments. By courtesy of The Lamplough Daylamp, Ltd.

A third type of lamp usually employs a simple coloured bulb, either of coloured glass or coated with a gelatin filter. The correction in many of these units is not nearly so thorough, and therefore the luminous efficiency can be kept much higher, perhaps up to 60 per cent. or so. While lamps of this kind give a much better sense of relative value to blues and greens, they are of little use when exact colour matching is of importance, and recourse must therefore be made to the more fully corrected units.

Other types of lamp, of Continental origin, employ two or more colour filters. The light transmitted through these filters is mixed by diffusion.

In considering the spheres of usefulness of such lamps as are at present available, we recall first of all the considerable number of industries in which "grading" and estimations of quality of products by visual appearance are of the greatest importance. Tea, leather, tobacco, seeds, flour, and many other materials are all judged by colour, and until the modern daylight lamps were available a very great deal of time was lost owing to the lack of good daylight often experienced during the winter in industrial towns. So far as can be judged, however, artificial daylight has proved entirely satisfactory for purposes of this kind when sufficient care is employed in choosing a lamp suitable for the work in hand. A jeweller requires a strong light concentrated in a small area, and for this work one of the lamps with a focussing reflector would be best. On the other hand, for warehouse lighting a lamp giving good diffusion, such as the Sheringham Daylight, may prove the more suitable. The fully corrected lamps have been adapted for studio lighting by artists, and for counter illumination in drapers' shops and elsewhere. Fig. 2 shows a "Lamplough" transmission unit in use for grading pigments at Messrs. Winsor and Newton's.

Persons with experience of work with the artificial daylight units learn to adapt their estimations to the relatively constant light of these lamps, and less difficulty is often experienced than in working with highly variable daylight.

The "higher efficiency," and less fully corrected, lamps are applied with success for the lighting of shop windows by drapers and florists. A great improvement in colour values is secured without undue expense. The main factor militating against the employment of artificial daylight for general lighting seems to be a purely psychological one. Objection is taken to the "cold" appearance of the light when contrasted with that from ordinary lamps, but after all the matter is scarcely of importance if the corrected light is readily available when required.

It may be recalled that the difficulty of obtaining a reasonably constant standard of white light is one of the greatest difficulties in the application of colorimetry for modern industrial purposes. Stanford (*Biochemical Journal*, xvii. No. 6, 1923) has recently pointed out the usefulness of an artificial daylight lamp (the Sheringham lamp was actually used) for purposes of colorimetry with limited range colorimeters,[1] and for many chemical estimations, such as comparisons in Nessler cylinders. Artificial light corrected thus, or by a suitable filter of daylight glass, or by one of the laboratory methods described above, is of the greatest service in the more general problem of colour measurement which is being investigated with much energy in Germany and America at the present time, although the subject seems to attract little attention in Great Britain.

In conclusion, one might comment perhaps on the lack of interest shown by commercial firms in the subject of artificial daylight, and the improvement of lighting generally. In 1920 there were 15,000 fully corrected artificial daylight lamps in use in America, and the demand was then rapidly growing. In Great Britain it is doubtful whether a tenth of the American demand has been reached. The saving of time effected by the employment of such lamps in bad weather is so great that this indifference seems extraordinary, and the sooner this state of affairs is remedied the better for those industries to which this subject is of importance.

[1] See "Colour and Methods of Colour Reproduction" (Blackie), p. 114.

The Plant Commonwealth and its Mode of Government.[1]

By Sir FREDERICK KEEBLE, C.B.E., F.R.S.

TO describe in any detail the different kinds of receptor, or receiving apparatus, whereby an external stimulus of light, gravity, etc., is registered by the plant, lies beyond the purpose of this discourse. It is, however, essential to that purpose to point out that the region of reception of the stimulus is often separated by some distance from the region of reaction. Cut or burn the root of a sensitive plant, and presently the leaves begin to move. First, those nearest to the base of the stem bend down hingewise on the leaf cushion (pulvinus) and their leaflets fold together; then in succession those higher up the stem undergo a like series of changes, until all have soon reacted to the shock. Place a root on its side and its growing region an inch or so behind the tip, elongating more on the upper than on the lower side, initiates a curvature which continues until the tip points again vertically downward. But if, as Darwin showed, the tip be cut off before the root is placed in a horizontal position, no curvature occurs until a new root-tip has been regenerated. In the intervening days the root continues to grow horizontally. Cover or cut off the tip of the first leaf of a grass seedling and the actively elongating region fails to respond by curvature to one-sided illumination.

It is therefore evident that there is often a definite separation of receptor and effector region, and one of the most interesting problems in plant physiology is to discover how that gap is bridged. In animals nerves serve to connect the receptor organs—the receivers of specific stimuli—and the effector organs—the structures which respond by movement or other definite changes. But though many have sought for and some have thought to find them, those specialised conductors of excitation which are called nerves appear to be absent altogether from plants. Some have believed that the intercellular protoplasmic fibres serve like nerves to conduct impulses. It may be so, but facts are not very favourable to this interpretation of their function. It would, indeed, seem more probable that the protoplasmic intercellular strands serve to transmit not nervous impulses but materials from cell to cell.

There is, however, no need to carry these speculations further, since recent discoveries have thrown a new light and put a different complexion on the mode of transmission of excitation in plants. If a little mica plate be inserted into a cut made half way across the

[1] Continued from p. 15.

tissue of the first leaf of an oat seedling at a short distance behind the receptive tip, excitation resulting from unilateral illumination is transmitted as in intact plants. But if a second plate of mica be inserted in a second cut made on the opposite side at a slight distance from the first no curvature results; the plant remains unresponsive to unilateral illumination. Similarly, as might be supposed, if the tip be cut off completely and replaced so that it rests on a plate of mica introduced between it and the rest of the leaf, curvature does not occur. But if the tip be cut off and glued on again with gelatin, unilateral illumination induces the same curvature as it does in the intact oat leaf. The receptor apparatus in the tip suffers no damage from the operation, and undergoes the same excitation as in the normal plant. This excitation passes through the gelatin to the intact effector region and brings about in that region redistribution and changes in rate of growth which are made manifest by curvature.

There would, therefore, appear to be no escape from the conclusion that that which passes from receptor to effector regions is a stimulatory substance—a hormone. The message transmitted by the receptive tip to the reacting region is a chemical message. As a letter in the post-bag may pass many doors and cause no stir until it is delivered at the right address, so the hormone which evokes heliotropic response passes through or by many cells without, so far as is known, producing any effect upon them. It is not for their address. Only when it reaches the cells beyond the growing point which have ceased to divide and begun to grow in length and breadth does the message which the hormone bears become significant. Similar beheading and reheading experiments have been made by Mr. G. R. S. Snow in my laboratory. Although it might seem unduly sanguine to expect anything to happen after a root tip has been cut off and stuck on again, the experiment, which has now been repeated many times, demonstrates that the receptive tip, after the operation, responds to the stimulus of gravity stimulation, and that the message which provokes curvature in the growing region is transmitted across a gelatin junction. For if after replacement of the cut off tip the root is laid in a horizontal position, instead of remaining in that position as a tipless root does, it curves until the tip points once again vertically downward.

No less remarkable are the discoveries which have recently been made by the Italian physiologist, Ricca, on the much investigated subject of the movements of the Sensitive plant, *Mimosa pudica*, and allied sensitive species. The movements of this plant have often been described and always excite wonder. In tropical countries, where the Sensitive plant grows close to the ground and covers large tracts, any one who walks over it may see the leaves bending down and folding up as his foot approaches, as though the plants were shrinking from impending danger.

Many explanations have been offered of the significance of these movements; but none seems satisfactory. Extreme sensitiveness to contact is not peculiar to the species of Mimosa. It is manifested also by other genera of plants, by Neptunia, which, like Mimosa, belongs to the Legume family, and by Biophytum, *e.g. Biophytum sensitivum*, a member of the Geranium family. A recital of all the interesting experiments which have been made on *Mimosa pudica* from the time of Claude Bernard to the present day is beyond my powers or your patience. Nor is the recital necessary for my present purpose, for the new classical experiments of Ricca, and the as yet unpublished experiments made recently by Mr. Snow, throw new light on the nature of the message which passes to the leaves when the plant is stimulated as it may be by tapping, shaking, cutting, or burning a part of it. Working with strong-growing woody species in the congenial climate of Italy, Ricca has shown that the excitation set up by stimulating a part of the stem travels in the wood. Even after all the other tissues of the stem are removed the excitation continues to pass upward and to bring about progressively the characteristic movements of the leaves. If a length of stem above the point to be stimulated is killed, as, for example, by subjecting it to high temperature, the message still passes and is delivered to the living leaves above the killed region of the stem.

That the excitation is of a chemical nature is shown by cutting the stem, interposing a short tube containing water between the severed ends, and then stimulating the lower part of the stem. Even under these untoward conditions the message is delivered. The hormone, rising with the water current up the vessels, diffuses through the column of water in the glass tube and, passing into the vessels above the cut, travels along them, and at each level at which a leaf is borne, the hormone passes into the motile pulvinus and excites its tissues, so that the turgid cells of the under side of the pulvinus lose water and resilience and, becoming flaccid, no longer bear up the leaf stalk, which therefore falls like a flag at half-mast. As in old times, a knocker-up went round the town leaving his noisy message at the appointed doors, so the hormone, albeit more discreetly, travels through the watery highways of the plant delivering its chemical message as it goes.

Research, however, whilst unveiling old mysteries discovers new ones, and Mr. Snow, who has just come back from studying the behaviour of Sensitive plants in the West Indies, informs me that whilst he has confirmed Ricca's remarkable results, and has shown that the hormone which travels through the wood may be made to diffuse across a film of collodion without losing its potency, has also discovered that this is not the whole of the story. Transmission of excitation in the Sensitive plant is apparently of two kinds. There is the relatively slow transmission of a specific hormone by way of the wood vessels of the stem; but there is also a high-speed transmission, far more rapid and much less far-reaching. When this high-speed transmission of excitation is employed by the stem, the track which it follows is not that of the wood vessels, nor does it lead to movement of more than two leaves above the point of stimulation.

Mr. Snow has demonstrated the existence of these two modes of transmission by the simple device of making very gradually an oblique cut in the stem. As the knife penetrates into the deeper tissues below the cortex—which tissues are known as the phloem or bast—a drop of fluid exudes from the cut. It used to be supposed that this exudation, which escapes from

certain long tubular cells, is the sign of some hydrostatic disturbance in these cells, and that this disturbance leads to the setting up of a pressure wave which evokes the movement of the leaves. But if the knife be stayed at this point, though the water drop gushes out, nothing else happens. Let it, however, be pressed a little so that it penetrates deeper into the bast and reaches to, or almost to, the cambium, which lies between bast and wood, and suddenly the high-speed transmission takes place; in a flash, the nearest two leaves fall. If the knife be withdrawn no further excitation takes place, but if it be pushed home into the wood, the second more leisurely mode of transmission comes into play. The chemical messenger which travels into the water current in the wood vessels is released and, slowly but surely, as the transpiration current rises through the stem, leaf after leaf falls until all have shown by their position that they have received and responded to the message.

These observations come opportunely. Without them I should have been tempted to round off my discourse with a confident generalisation. The varied happenings in the plant commonwealth which I have described—the revival of powers of cell-division in wounded tissues, the heliotropic curvatures of roots and stems, the ordinary response of the Sensitive plant to shock—all are brought about by specific chemical messengers or hormones. Many other phenomena of plant response to stimulation are undoubtedly also due to hormones. May it not therefore be that the mode of government of the plant commonwealth is not duplex, like that of animals, but simplex? Whereas the integration of the animal body into an individual is the outcome of messages of two kinds, the integration of the plant body is effected by messages of one kind only. In the animal body, the two kinds are those messages transmitted at high speed along the nerves and those material messages or hormones, which are distributed by means of the blood stream. In the plant body, messages of the latter kind only are at present and with certainty known to pass to and fro between the members of the commonwealth.

Until, however, the nature of the high-speed transmission of excitation in Mimosa is explored, it would be rash to predict confidently that the fundamental difference between plant and animal will be found to lie in this, that the plant commonwealth has not and never had the means of rapid message-sending which in the animal world takes place by means of the nervous system, and that the passionless perfection of plants has been achieved solely by developing the system of special messengers. Or adopting Bayliss's metaphor: If the integration of the animal is to be regarded as due to the simultaneous employment of a telegraph system and a postal service—one for quick messages which may be of a physical kind, the other for less rapid messages of a material kind—then it may be that the integration of the plant commonwealth has been and is effected solely by the employment of the postal system. One—the animal world—partakes rather of the nature of an empire, and the other—the plant world—partakes of the nature of a commonwealth, and if so the title of my discourse needs no further justification.

Obituary.

PROF. J. G. LONGBOTTOM.

THE death has been announced, at the early age of fifty-four, of Prof. John Gordon Longbottom, of the Royal Technical College, Glasgow, which occurred on June 6 after a serious operation. Prof Longbottom was a native of Keighley, Yorkshire, and served his apprenticeship in engineering in the works of Messrs. F. and J. Butterfield. His technical education was received at the Bradford Technical College, and a Whitworth Scholarship enabled him to proceed to the Royal College of Science and University College, London, where he became an assistant to Prof. Karl Pearson. About twenty-eight years ago he joined the staff of the Ro ya Technical College, Glasgow, and became professor of mechanics on the retirement of the late Prof. Rowden.

Prof. Longbottom was very retiring, and consequently his abilities were not widely known outside the College. His mathematical knowledge and his power of applying it to practical problems were of great advantage to his students, who will remember him not only for the soundness of his work, but also for the kindliness of his disposition. His appointment was made prior to the erection of the new buildings of the College, and he was therefore responsible for the equipment of the Materials Laboratory—an installation which is worthy of the College. He was a member of the Institution of Mechanical Engineers and of the Institution of Engineers and Shipbuilders in Scotland; he contributed to the latter Institution a paper on the stresses on the rim and arms of a flywheel.

PROF. IAN DEYL.

PROF. IAN DEYL, who died on February 4 in Prague, was born in 1855 in Vysoké Veselí nad lidlinon, and prepared himself for the duties of an all-round practical surgeon. But at last he became an ophthalmologist. I cannot dwell here on his numerous original investigations so far as they refer to medicine, of which the most interesting ones treat of the relations of eye diseases to the diseases of the body. He solved in fishes and birds the most complicated problem of the embryology of the mechanism of the eye, namely, the way in which the crossing of the eye-nerves on the lower part of the skull takes place.

Deyl was a member of the Bohemian Academy of Sciences, of the Royal Society of Bohemia, of the Ophthalmological Society, etc. He was of noble character and a great benefactor of the blind, and an institution for the blind bears his name.

BOHUSLAV BRAUNER.

We regret to announce the following deaths:

Dr. C. E. Moyse, emeritus vice-principal of McGill University, Montreal, aged seventy-two.

Sir Jethro Teall, F.R.S., lately Director of the Geological Survey of Great Britain and of the Museum of Practical Geology, London, on July 2, aged seventy-five.

Sir Harry Veitch, formerly vice-president of the Royal Horticultural Society, on July 6, aged eighty-four.

Current Topics and Events.

A CONFERENCE arranged at the British Empire Exhibition by the Royal Society for the Protection of Birds took place on June 26. The subjects for discussion were legislation for bird protection in different parts of the British Empire, the oil menace, and the formation of Nature reserves and bird sanctuaries. Overseas representatives described the conditions in their respective countries. In some of these the question of the preservation of bird life is a very urgent problem: on the one hand the changes within recent years—owing to the rapid increase of human population and all that it implies—are very obvious, while on the other hand the need for counteracting insect pests is particularly great. In some parts of the Empire, legislation on the subject is ahead of that in Great Britain, but although high penalties are imposed, enforcement of the law is often difficult. One is glad to see this subject discussed in its wider aspects, even although foreign countries were on this particular occasion not included. Owing to the seasonal movements of birds from one country to another, international co-operation in protective measures is highly desirable, and we were told at this conference how much the Migratory Birds Treaty with the United States has done for the Canadian summer avifauna. The oil menace also requires international handling, because the waste oil which nowadays causes so much cruel and unnecessary destruction of birds, as well as of fishes and other marine animals and of seaside amenities, is as a rule originally discharged at sea outside territorial limits.

AT the close of the current session, Prof. J. B. Cohen will retire from the chair of organic chemistry in the University of Leeds, severing a connexion which dates back to 1891. In that year, after some experience in the works of the Clayton Aniline Company and in the Chemistry Department at the Owens College, Manchester, he was appointed lecturer in organic chemistry and afterwards became the first occupant of the chair of organic chemistry established in 1904. To the advancement of organic chemistry Prof. Cohen has contributed very substantially in many ways. His original work has centred, for the most part, in problems connected with substitution in aromatic compounds, with the relation between optical activity and position isomerism and with the influence of chemical constitution on the antiseptic properties of organic compounds. His success as a University teacher has been in no small measure due to his faculty for lucid exposition, to his constant attention to the routine laboratory work of his students, and to his never-failing interest in the difficulties of the beginner. To large numbers of organic chemists, his name is particularly familiar as the author of widely read text-books which have played no small part in attracting students to the study of the subject. As a member of Government Committees dealing with the question of smoke abatement, Prof. Cohen has been able to supply valuable data from first-hand observations on the deleterious effects of smoke. Much of his leisure has been given up to social work, and as president of the University Working Men's Club at Leeds, he has, with much success, laboured to bring University students into contact with young working men, to their mutual advantage. In recognition of his services the funds necessary for the establishment of an annual University prize are in course of being provided by Prof. Cohen's colleagues, friends, and past students. To his colleagues, the approaching retirement is an event rendered less regrettable by the knowledge that arrangements will probably be made for him to continue his experimental work in one of the University laboratories.

A MOST interesting appreciation of Lord Kelvin, the centenary of whose birth has just been celebrated, appears from the pen of Sir Oliver Lodge in a recent number of the *Observer*. As a physicist who can enter into the spirit of Kelvin's work in a way that few others can, Sir Oliver sums up the scientific career and genius of the great pioneer with a wonderful sense of proportion. Attention is directed not only to the vast mathematical power and knowledge that he possessed and applied with such notable results to the foundations of thermodynamic and electromagnetic theory, but also to his all-compelling enthusiasm and his remarkable originality and independence of thought. "Many a German professor and some English professors," writes Sir Oliver, "were more learned than Lord Kelvin, but none were so original. . . . His métier was not to follow but to lead." This independence of thought sometimes brought him into avenues from which he was obliged to retreat. The writer pays great tribute to the practical results of Kelvin's labours. His navigational and electrical instruments are household words to-day, and many of his theories have had unexpectedly far-reaching results. He was, however, not always a good judge of his own work. Sometimes he lost his way and floundered. He was an inspiring rather than a safe and secure guide. "But," concludes Sir Oliver, "he has written his name large on the history of physical science, and all the world marvels at his genius and is thankful that he lived."

THE work of William Pengelly as a geologist and as the explorer of Kent's Cavern will always be remembered by scientific workers, and some of his papers must ever figure among the classics of geological literature. The celebration last month of the jubilee of the foundation of the Museum of the Torquay Natural History Society is a reminder of the way in which he has left a mark in the town which will keep his memory ever fresh in the minds of all who know Torquay. In 1844, Pengelly, Dr. Battersby, Mr. E. Vivian and some fifteen kindred spirits founded the Society, but it was not until 1874 that the foundation stone of the Museum was laid by the Rev. T. R. R. Stebbing, president for the year, who is still with us. In March 1894, Pengelly died and a good lecture hall was added to the building as a monument to his memory. For many years the building has been a worthy focus for the scientific thought and work of the Torquay district, a region peculiarly rich in opportunities for

research. Mr. Harford J. Lowe, the honorary secretary, speaking at a garden party held at Torre Abbey, said: "The life of the Society must be credited in a very large measure to the incomparable work, during many years, of Mr. Pengelly, who through his excavations in Kent's Cavern provided the mainstay of the Society and gave it world-wide notability." This note was echoed at a garden party given by Pengelly's daughter, Mrs. H. Forbes Julian, on the following day, and again by an account she gave to the Society of her father's work. "A man," she said, "is best judged by the work he has done, the influence he has exercised during his lifetime, and the results he has left behind for the use of posterity."

TAKING the weather records at Greenwich Observatory as a fair representation of Midland and South-east England, a consideration of the meteorological results for the first six months of the current year shows a prevalence of dull and rainy weather. The mean temperature for the six months is 0°·15 F. above the normal for the past 35 years, and whilst January, May, and June were warmer than the normal, the months of February, March, and April were colder than the normal In May, the shade temperature was above 70° on 8 days, the highest reading being 79°; the temperature in the sun's rays was 130° or above on 14 days, the highest reading being 150°. In June, the shade temperature was above 70° on 16 days, and on 2 days it was slightly above 80°; the solar radiation temperature was 130° or above on 16 days, and the highest reading was 149°. The rainfall was in excess of the normal in all of the six months except February and March, yielding a total excess of 2·41 in.; the latter half of June was generally dry, rain only falling on 3 days after June 13. Bright sunshine was deficient in all the six months except January and March, the deficiency for the whole period averaging about a quarter of an hour per day; in April the bright sunshine was 1·66 hours per day less than the normal. Although the weather has continued somewhat unsettled there has fortunately been no recurrence of late of the abnormal conditions which continued with such persistence during the winter and early spring.

IN the *Times* of July 2, Mr. Richard O. Marsh publishes an amplified account of the previously reported discovery of "white Indians" in the district of Darien in Panama. The expedition of which Mr. Marsh was leader made friends with the Indians of the district by rendering medical aid in an epidemic of small-pox. They were then induced by an offer of the assistance of the white man against the surrounding "negroid" tribes to end their feud with the "white Indians," who, as the story goes, were either killed or driven to the mountains at the time of the Spanish occupation (1512–1517) owing to the hatred of all white people which had been aroused by the cruelties of the Spaniards. Notwithstanding a ban on their marriage and an order that all their children should be killed, the type has survived ever since. As a result of Mr. Marsh's intervention, the "white Indians" have been re-admitted to full tribal rights. Dr. Breder of the American Museum of Natural History says in a telegraphic despatch that the three "white Indians," whom Mr. Marsh hopes to bring back with him to the United States, have golden hair, blue eyes and white skins, though two have "liver spots," while their skulls are unusual, being round and quite unlike the San Blas Indian type.

To the *Empire Review* for July, Mr. Hugo Hirst contributes a thoughtful paper on the World Power Conference. He points out that power schemes require capital, and this capital can only be obtained by international co-operation. The Conference attacks this problem, and the many papers contributed by authors will be a help in finding a solution. Recent developments in the industrial world will probably determine the course of the economic reconstruction of the world. In the author's opinion, this reconstruction can already be seen to be slowly emerging. Increased international co-operation is wanted in science, in engineering, and in research. Modern industry is based entirely on science, and its continuous development is only possible through research. The great inventions such as those made by Watt and Faraday are essentially simple. To put them into practice, however, requires the expenditure of capital, and only large firms can face this expenditure. To the manufacturer, research is an economic proposition. In Great Britain the question of coal conservation becomes more pressing every year. Our easily worked reserves of coal are diminishing, and so the price of coal is increasing. The cost of fuel is a greater burden on industry than ever it has been before. The many papers read at the Conference showing how other countries are attempting to solve the problem will be of permanent value to every engineer.

AT the World Power Conference at the British Empire Exhibition, papers by Mr. J. W. T. Walsh, Mr. L. Gaster and Mr. C. W. Sully dealing with illumination were read on July 4. As Dr. C. H. Sharp, a delegate from the United States, remarked in opening the discussion, it seems an anomaly that out of the very large number of contributions to this conference only three should deal with lighting. For it is estimated that quite half of the total electrical energy produced is applied in the lighting field. Mr. Walsh's paper was concerned chiefly with the activities of the International Illumination Commission, whilst Mr. Gaster showed how these are linked to other organisations concerned with illumination from the national point of view. Mr. Sully's paper was largely statistical. He showed how the average candlepower of lamps used has progressively increased during recent years, and gave some illustrations of the great opportunities for developments in lighting. There is of course every inducement to companies concerned with the manufacture of lamps or the supply of electricity to encourage the study of illumination. But one is glad to note that this interest is not confined to the purely commercial side. It is essential that the views of experts, especially those concerned with the hygienic aspects of lighting, should be heard and that the subject should be developed on scientific lines.

THE value of the agricultural exhibit (Ministry of Agriculture) in the Government Pavilion at the British Empire Exhibition, Wembley, has been considerably enhanced by the issue of a descriptive guide-book providing a short explanation of most of the exhibits. More than a score of research institutes have co-operated in working out a definite scheme, starting with an exposition of soil problems and conditions, leading through a demonstration of methods of plant and animal improvement to problems of nutrition and pathology, and concluding with the economic aspects under the headings of Horticulture and Farming and Agricultural Economics. The guide-book does not attempt to describe each exhibit individually, but gives a short, general outline pointing out what each case is intended to demonstrate. In some instances, as in connexion with wheat breeding, virus diseases and spraying with insecticides, the principles upon which the research is based are given in some detail, to render the object of the work intelligible to the public. In other cases, as with the life histories of insect pests and the section devoted to farm machinery, attention is specially directed to the results already obtained and their application in practice. A further useful purpose served by the publication is to indicate the interdependence of the various branches of agriculture, and to demonstrate the wide range of interests involved and the widely spread efforts that are being directed towards the improvement of this great national industry.

THE Meteorological Office has an exhibit of its work in the Government Pavilion at the British Empire Exhibition, Wembley, and an account of the exhibits appears in the *Meteorological Magazine* for June. The entrance to the meteorological section is at the back of the Government Pavilion. Numerous instruments necessary for weather records and weather forecasting are on view. A continuous record is given of the direction and speed of the wind over the building obtained from a Dines pressure tube anemograph, and the intensity of the rainfall is recorded by an autographic rain gauge. A balloon meteorograph is exhibited, and there is a large working model of this to show how the results are obtained. The instrument records temperature correctly to 1° C. and pressure correctly to within a few millimetres. The walls are hung with specially prepared diagrams illustrating different branches of the work. The preparation of forecasts is demonstrated by members of the office staff and data are collected by a wireless installation from a great part of the Northern Hemisphere. There can also be seen the meteorological log kept on board H.M.S. *Thrush* when His Majesty as Prince George was in command. The importance of meteorology is evidently being increasingly acknowledged.

IN an article in the issue of *Science* for May 2, Prof. F. Cajori of the University of California disposes of some of the more or less popular legends which have grown up with regard to Sir Isaac Newton and his work. The delay of twenty years in the publication of the law of gravitation was not due to his taking 60 instead of 69 miles as a degree of latitude, but to his uncertainty as to how a sphere attracted a particle outside it. The delay of the Royal Society in publishing the "Principia" was not due to the absence of any reference in it to Hooke's previous statement of the inverse square law, but to Newton's desire to stop publication. He did not believe as Cotes, the editor of the second edition of the "Principia" did, in action at a distance, but postulated a medium requiring time to act. He did not reject the wave theory of light in favour of the corpuscular theory, but made use of the idea of ether vibrations wherever it seemed the more suitable. The authoritative works of Brewster, Horsley, and Rosenberger provide no support for these legends, but this cannot be said of the "Encyclopædia Britannica" article on Newton.

IN our issue of June 28 we recorded the tragic death of two members of the Mount Everest Expedition, Mr. G. L. Mallory and Mr. A. C. Irvine. The information then available was a brief telegram; a dispatch which tells us all that is likely to be known has since appeared in the *Times* of July 5. From Lieut.-Col. E. F. Norton's message it appears that the surviving members of the party were to leave the base camp on June 15 for the Rongshar Valley, there to rest for a short period before starting on the homeward march. All the party were suffering from the effects of the high altitude work, and no further attempt to scale Everest will be made this season. Mr. Odell, who was the last to see the two lost climbers, takes up the story and describes the events leading up to the final attempt. On June 6, Mallory and Irvine left the North Col Camp for Camp V. (25,000 ft.), and the next day they went on to Camp VI. (27,000 ft.), which had been established by Norton and Somervell a few days before. The same day Odell arrived in support at Camp V. On June 8, Mallory and Irvine appear to have started on the last stage of the journey to the summit, and at 12.50, in the course of making a survey of the mountain face between Camps V. and VI., Odell observed two figures moving on the mountain above him, a comparatively short distance from the summit. Odell then returned to the North Col, and with Hazard kept watch for the return of the climbers. As they had not returned on the following day, Odell climbed again to Camp V., proceeding to Camp VI. on the next day, but no trace was found of the missing men. To search further was impossible, and the party had to withdraw. The position in which Mallory and Irvine were last seen was determined by theodolite as 28,227 ft. Odell is of opinion that they achieved success but were overtaken by darkness on the return journey, and with this conjecture it seems we must be content.

IN connexion with an article in our issue of April 12 on foot-and-mouth disease, the statement was made that "no one believes that the disease arises *de novo*." M. C. D. Perrine, of Cordoba, Argentine, writes to ask why this belief is held when it must be supposed that diseases must at one time have originated on the earth. This is no doubt true if one is not limited to time. It is a certainty that diseases like smallpox, leprosy, plague and consumption have existed as long

as we have any historical knowledge, and probably for a much longer time. Syphilis is a disease which was formerly believed to have originated *de novo* or was brought to Spain in 1493. The more modern study of original documents has shown that this is most improbable, and there is an accumulating bulk of evidence that syphilis also is an ancient disease. The more rigorously infective diseases are studied, the more easily can it be proved that they are transmitted in succession through a long series of generations.

AT a time when there are signs of an increasing interest in algæ, algologists in all parts of the world will welcome the appearance of a new periodical devoted entirely to their science. The *Revue Algologique* is edited by Dr. P. Allorge and M. G. Hamel, of the Museum d'Histoire Naturelle, Paris, and these French algologists are to be congratulated on their energy and enthusiasm in launching a new journal. The *Revue* is published quarterly, and is obtainable from M. Gontran Hamel, Laboratoire de Cryptogamie, 63 rue de Buffon, Paris 5e; price in France 25 fr., outside France 35 fr. It will contain reviews of all algological papers, commencing with 1923, and is open for original contributions. The first part now issued is well got up and consists of 96 pages. There are several original articles in French and English.

A REPORT recently issued by the Board of Education deals with the progress of the Science Museum during the years 1921 and 1922. The Museum appears to have been much hindered by lack of accommodation, part of the collections (and particularly that relating to fishery) being stored away; while the task of transferring about half of these to new quarters gave the staff plenty of occupation, new (but inadequate) buildings having been put in hand in 1922 so as to become available in instalments in lieu of space ceded to the Imperial War Museum. In spite of these difficulties, creditable progress was made: a number of new exhibits were incorporated, including a historical collection of electrical apparatus lent by the Institution of Electrical Engineers and one illustrating the history of kinematography lent by Mr W. Day, the series relating to light road transport and to wireless communication were specially developed, an improved system of indexing was introduced and completed, catalogues were published for the sections dealing with textile machinery, aeronautics and meteorology, and much repairing and preparation of models was carried out in the workshops. A minor piece of work of some importance was that undertaken in connexion with the Eötvos torsion balance in the Museum. To the Science Library more than 5000 volumes and 15,000 parts and pamphlets were added, and a new classification scheme was put into effect. The number of readers averaged less than forty a day. The smallness of this number is doubtless due to the fact that the library is less known to scientific workers than it should be.

THE Report of the International Air Congress held in June 1923 has recently been issued as a portentous volume of nearly 1000 pages, edited for the Committee by Lieut.-Colonel W. Lockwood Marsh (London: Royal Aeronautical Society, 1923. 25s). It embodies a mass of papers and discussion on every field of aeronautical interest, aerodynamics and meteorology, engines and fuels, strength of construction, commercial aviation, legal questions, and medical problems arising out of aeronautical accidents. It is a wonderful record of achievement in so youthful a science. There were gathered together 551 representatives of 21 different nations, but the ex-enemy countries were conspicuous by their absence. This is the more to be deplored since some of the more recent and fundamental advances have been developed by the latter. An international discussion on aerodynamics without Prandtl is like relativity without Einstein The report demonstrates the useful purpose served in effecting comparisons between the experimental methods pursued in different countries, and stresses the value of standard comparative tests in all existing wind tunnels. Contributors included members of the staffs of the National Physical Laboratory, Royal Aircraft Establishment and of the corresponding institutes in France, Holland, Italy, and the United States. The volume may be taken in fact as the most recent authoritative statement of the present position of aeronautical science both on the theoretical and on the experimental sides. The report is unfortunately marred by a number of misprints in formulæ.

SIR NAPIER SHAW, professor of meteorology in the Imperial College of Science and Technology and formerly director of the Meteorological Office, has been elected a foreign member of the Royal Swedish Academy of Science in respect of his "masterly researches on the domain of meteorology."

A SUPERINTENDENT of Fishery Investigations is required for the purpose of organising a new department of fishery research in the Straits Settlements and Malay States. Particulars of the duties of the post and forms of application may be obtained from the Private Secretary (Appointments), Colonial Office, S.W.1.

APPLICATIONS are invited for two appointments in the Department of Agriculture, Nairobi, Kenya Colony, namely, an agricultural assistant with experience in agricultural practice and ability to carry out crop experiments and to render itinerant and advisory services, and an agricultural chemist able to take charge of the chemical branch and to initiate and undertake research. Applications, upon a prescribed form, must be received before July 15 by the Private Secretary (Appointments), Colonial Office, S.W.1.

THE second annual corporate meeting of the Institution of Chemical Engineers will be held at the Hotel Cecil on Wednesday, July 16, when the president, Sir Arthur Duckham, will deliver his presidential address. During the afternoon session Sir Frederic Nathan will review the work of the Education Committee on "The Training of a Chemical Engineer." The meeting will conclude with a visit to the British Empire Exhibition, and a tour of the Chemical Hall will be made under the guidance of Mr. W. J. U. Woolcock.

THREE Agricultural Inspectors are required for the Agricultural Department, Iraq Candidates should be honours graduates of a British university, holding a diploma in agriculture, or possessing similar qualifications. The persons appointed will be responsible for work mainly in connexion with cotton development, and there are opportunities for original research in agricultural economics. One of the selected candidates may be appointed Assistant Director of Agriculture at headquarters. It is therefore desirable that at least one of the candidates appointed should have had experience of editorial work in addition to other qualifications required.

MISS C. F. ELAM has been appointed to the research fellowship in metallurgy, of the value of 500*l*. a year for five years, given by the Worshipful Company of Armourers and Brasiers in the City of London, and awarded through the Royal Society. Miss Elam was a student of Newnham College, Cambridge, and has been engaged in research work on the properties of metallic crystals with Prof. H. C. H. Carpenter at the Royal School of Mines for the past few years. She also investigated the method of distortion of aluminium crystals in tension, in conjunction with Prof. G. I. Taylor, at the Cavendish Laboratory, Cambridge, and the results of this investigation formed the subject of the Bakerian Lecture of the Royal Society for 1923.

THE Council of the Royal Society of Arts has awarded the Society's Silver Medals for papers read before the Society during the past session as follows: (*Ordinary Meetings*)—Sir Frank Baines, "The Preservation of Ancient Monuments and Buildings"; Sir Richard A. S. Paget, Bt., "The History, Development, and Commercial Uses of Fused Silica"; Major-Gen Sir Fabian Ware, "Building and Decoration of the War Cemeteries"; Mr. Frank Hope-Jones, "The Free Pendulum"; Brig.-Gen. Sir Henry Maybury, "The Victoria Dock District and its Roads"; Mr. T. Thorne Baker, "Photography in Industry, Science and Medicine"; Mrs. Arthur McGrath (Rosita Forbes), "The Position of the Arabs in Art and Literature." (*Indian Section*)—Brig.-Gen. H. A. Young, "The Indian Ordnance Factories and Indian Industries"; Sir Richard M. Dane, "Manufacture of Salt in India." (*Dominions and Colonies Section*)—Prof. C. Gilbert Cullis, "A Sketch of the Geology and Mineral Resources of Cyprus"; Sir Frederick Lugard, "The Mandate System and the British Mandates."

Our Astronomical Column.

ENCKE'S COMET.—This is the best known of all the short-period comets, and has been observed at every return for the last century. L. Matkiewicz has taken charge of the computations regarding it that were carried on for a long period by the late Prof. Backlund. He notes that a marked change in the mean motion took place in 1918, similar to that in 1904. Since observations in 1921 were confined to a fortnight, it is very desirable to observe the comet over a long arc at the present return. Its detection in July is possible, and it should certainly be found before the end of August.

The following elements, which include perturbations by Jupiter only, are from *Astr. Nachr.* 5298:

$$\begin{array}{ll} T & \text{1924 Oct. 31, 429 G.M.T.} \\ \omega & 184^\circ\ 43'\ 43'' \\ \Omega & 334\ \ 37\ \ 33 \\ i & 12\ \ 30\ \ 21 \\ \phi & 57\ \ 48\ \ 28 \\ \mu & 1074''\cdot092 \end{array}\quad \left.\begin{array}{l}\omega\\ \Omega\\ i\end{array}\right\} 1924\cdot0$$

EPHEMERIS FOR GREENWICH MIDNIGHT.

	R. A.	N. Decl.		R. A.	N. Decl.
July 16.	$2^h\ 46^m\ 37^s$	24° 30′	July 28.	$3^h\ 14^m\ 57^s$	27° 9′
" 20.	2 55 46	25 20	Aug. 1.	3 25 16	28 8
" 24.	3 5 10	26 14	" 5.	3 36 17	29 8

Values of log r, log Δ on Aug. 1: 0·2294, 0·2268.

The comet is a morning object, rising 5 hours before the sun in mid July.

TOTAL LUNAR ECLIPSES.—An article by W. J. Fisher in Brit. Astron. Assoc. Journal for May gives useful hints on the observation of total lunar eclipses. These phenomena were for long regarded as of little scientific value. Then opportunity was taken to improve our knowledge of the moon's diameter by making numerous observations of occultations at the darkened limb. Afterwards it was recognised that study of the illumination of the eclipsed moon gave useful information on the average transparency of the air in the regions for which the moon was in the horizon. A map of the circumstances of the eclipse of Aug. 14 next (partly visible in England) makes it easy to locate these regions for every phase of the eclipse. They lie to a considerable extent over Europe, Africa, and South America, so that direct meteorological observations will be available for comparison with those given by the eclipse.

It is suggested that spectroscopic observations with a large lens and short focus might be made during totality; also the use of screens of various colours might enable more exact determinations to be made of the colours of various parts of the disc. The study is an easy and attractive one for amateur observers.

REPORT OF THE BERGEDORF OBSERVATORY.—This Observatory is carrying on an active programme of work in various fields under its director, Prof. R. Schorr. A second appendix to his "Eigenbewegungs-Lexikon" has just appeared, containing 1248 new proper motions, mostly of stars from magnitudes 6 to 9 and Right Ascensions from 0^h to 2^h; the astrographic and other recent catalogues have been used in preparing it.

The meridian work at the Observatory includes the re-observation of stars in Rümker's Catalogue, of which a revision was recently published.

Dr. Baade uses the reflecting telescope for the photography of minor planets and comets; the comet found by him in 1922 was followed until the early months of 1924. The very interesting planet 944, found by him, which travels all the way from the orbit of Mars to that of Saturn, has received the name "Hidalgo," after the Mexican hero; this is in recognition of the warm reception given to the German Eclipse Expedition to Mexico in September 1923. Masculine names are given only to minor planets with exceptional orbits, such as Eros and the Trojans.

Prof. Schorr is further engaged on the great "Geschichte des Fixsternhimmels," which contains a summary of all meridian work on the stars from 1750 to 1900. The first 2 hours have already appeared. This work was begun by Ristenpart at Berlin, but was interrupted by his departure to South America, where he died.

Research Items.

PALÆOLITHIC SKULLS FROM CAVES IN SOMERSET.—Vol. ii. part i. of the Proceedings of the Spelæological Society of the University of Bristol contains an important communication by Sir Arthur Keith, describing the skulls found in Aveline's Hole, Burrington Coombe, Somerset. This cave, as has been shown by excavations carried on by members of the Society, served as a dwelling-place—and as a burial place—for man in the closing phase of the Pleistocene period. Of the three skulls described, one is dolichocephalic and two are brachycephalic. Notwithstanding this difference, Sir Arthur Keith is of the opinion that they belong to the same race, the variation in length-breadth index being negligible in view of the identity of other characters, notably the high-pitched cranial vault. In this respect they compare very closely with the new Solutré crania and the Chancelade skull. Their discovery is peculiarly worthy of note, as no brachycephalic skulls of palæolithic date have hitherto been found in England. Although they differ in outline very decidedly from the late palæolithic skulls found both at Ofnet and Furfoos, yet in absolute length and breadth they show a close correspondence to those from the latter locality, while at least four of the intermediate series from Ofnet are comparable to them. Sir Arthur Keith regards them as of Azilian date, but Mr. J. A. Davis in his third report on the excavations, which appears in this issue of the proceedings, holds rather that the Aveline's Hole culture represents an isolated survival of Aurignacian into the late Magdalenian times, to which the occurrence of a typical harpoon, previously reported, seems to point.

MOURNING CAPS OF MURRAY RIVER NATIVES.—Mr. Edgar R. Waite, Director of the South Australian Museum, directs attention in vol. ii. No. 4 of the Records of that institution to a point connected with the mourning caps of the Murray River Natives which has hitherto escaped notice. The mourning caps worn by the widow, relatives of the deceased, and others, after a death, were built up of moist clay on the foundation of a net placed on the head of a mourner, usually said to be shaved for that purpose. Such mourning caps were, naturally, adapted to the shape of the head of the wearer, and also show traces of the process of building up, which was done gradually at different times. These were placed on the grave after an interval. There are, however, other forms of mourning caps which show no trace of having been built up on a foundation, and have obviously been made in one operation; also the interior is neither deep enough nor of the shape to fit on the head. It is suggested that they were dummies which were placed upon the grave by those relatives and others who had ceased to wear a clay cap as a sign of mourning, as the widow continued to do, but still used them in their dummy form as a ceremonial mark of respect to the deceased.

THE ANTS OF KRAKATAU.—In *Treubia*, vol. v. Nos. 1-3, Feb. 1924, Prof. W. M. Wheeler describes a collection of ants made during 1919–21 on Krakatau and adjacent islands and sent to him by Dr. K. W. Dammerman. During the great volcanic eruption of 1883 the fauna and flora of Krakatau, Verlaten, and Lang Islands were completely destroyed, and even Sebesi, at a distance of 15 km., seems to have suffered a similar fate. The study of the animals and plants that are gradually repeopling the islands has received considerable attention. In so far as ants are concerned, it appears that Dr. Dammerman has nearly doubled the known forms from Krakatau, and has much more than doubled the number of those known from Verlaten. The previous collector (Jacobson in 1908), however, used less refined methods of collecting so that the increase may not be entirely due to more recent arrivals on the islands. Most of the ants in the Krakataû group are common species of a wide range in the Indomalayan or even in the Neotropical region. They are hardy forms which survive anywhere in warm countries. Dr. Dammerman believes that many insects may have reached the islands as eggs, larvæ or pupæ, on drifting wood or plants, but contends that dispersal by air plays a more important part than is usually attributed to it. It is significant in this connexion that only one species of ant with wingless females is recorded by Prof. Wheeler in the collection; this evidently supports Dr. Dammerman's opinion.

ENTOMOSTRACA FROM COLORADO.—G. S. Dodds describes the Entomostraca collected by Dr. H. L. Shantz in 1903 and 1904 on the slopes of Pikes Peak (10,000 to 12,000 ft) and from ponds on the plains near Colorado Springs (6000 to 7000 ft.) supplemented by other records from the State of Colorado (Proc. U.S. Nat. Mus., lxv.). Situated astride the Continental divide, Colorado is the meeting-place of eastern and western faunas, and includes portions of five life zones. The 31 species of Entomostraca found by Shantz fall into three natural groups: 13 found on the plains but not on the mountains; 9 found only on the mountains; and 9, able to live in both warm and cold water, found in both groups of lakes. A similar tripartite division was observable in those collected in Colorado by the author. A graphic representation of the altitudinal range of these species is given, and the author dwells on the significance of these records, especially when it is remembered that the extremes of the two groups of lakes are separated at the most by not more than 10 miles, and yet support Entomostracan faunas as distinct as if separated by hundreds of miles in a north and south direction. The several species common to the two groups stand in strong contrast to the others, and serve to emphasise the fact that temperature may be an effective barrier for some species, but not for others. The paper concludes with a list of the lakes and the species of Entomostraca found in each, with other details.

FEEDING AND DIGESTION IN NEPHROPS.—C. M. Yonge (*Brit. Journ. Exp. Biol.*, vol. 1, pp. 343-389, 1924) gives an account of the mechanism of feeding and the process of digestion in *Nephrops norvegicus*. He describes the anatomy, histology and mode of action of the various parts of the alimentary tract, and records that the enzymes of the hepatopancreas digest starch, glycogen, sucrose, maltose and lactose; the amylolytic ferment finding its optimum in a neutral medium at a temperature of 57° C. The hepatopancreatic secretion also contains a fat-splitting enzyme and a powerful proteolytic enzyme. As in other crustacea, the hepatopancreas stores fat and glycogen, but apparently not calcium.

THE LARVÆ OF THE PEA CRABS.—The zoea larvæ of the pea crabs (Pinnotheridæ) have been studied by O. W. Hyman (Proc. U.S. Mus., vol. 67, Art. 7, 1924) at Beaufort, North Carolina. Ovigerous females were collected and kept in the laboratory until hatching of the eggs took place. The eggs hatch at nightfall. The only feature that is common to the zoea larvæ of this family and serves to distinguish them from the zoeæ of other families is the minute

size of the antenna. In other families the arrangement and size of the spines of the carapace are usually distinctive features of the zoea, but in pinnotherids there is no uniformity in this respect; spines may be prominent or entirely absent. The author gives a key to the known zoeæ. The complete history of metamorphosis has not been followed in any species, but it seems probable that the pinnotherids have at least three—probably four—zoeal stages followed by a megalopa and by the young crab.

TERTIARY CIRRIPEDIA FROM HAITI.—The specific distinctions in Balanus being based upon the opercular plates, no species can be well established until these are known. In their absence the characters of the walls and basis have to be relied upon, and in forms from a restricted area fairly satisfactory results can thus be obtained. Working on these lines, Dr. H. A. Pilsbry describes three forms from the Miocene of Haiti (Proc. U.S. Nat. Mus., lxv.), of which one is doubtful, one described as a new subspecies, and the third as a new species. At the same time, he admits that in the absence of the opercular plates comparison with European Tertiary species is impossible.

PŒCILOZONITES, RECENT AND FOSSIL.—Those interesting land snails belonging to the genus Pœcilozonites are peculiar to Bermuda, and though the living forms have long been known, it is only within comparatively recent years that the fossil ones have been studied. Some of these fossil forms are now dealt with by Dr. H. A. Pilsbry (Proc. Acad. Nat. Sci. Philad., lxxvi.), who proposes two new subgenera: Gastrelasmus for the species having a long, entering palatal lamella, type *P. circumfirmatus* (Redfield), and Discozonites, type *P. blandi*, n sp. Several new species and varieties are described and illustrated by text figures. Lieut.-Col. Peil, who has recently written on the same subject, states, however (Proc. Malac. Soc. Lond., xvi. pp. 18, 19), that in the living *P. circumscriptus* the internal lamella is sometimes absent.

IMPORTANCE OF MANGANESE IN PLANTS.—J. S. McHargue (*Journ. Agric. Research*, xxvii. No. 6) claims to have obtained data showing conclusively that manganese is an essential element in plant economy and performs an important function, perhaps catalytic, in the synthesis of chlorophyll. Other experiments are being conducted to discover whether manganese is also a vital factor in animal nutrition. In view of the results obtained, and also of the fact that manganese is found in greater quantity in those plant and animal tissues which are richest in vitamins, the author is led to assume that a relationship exists between this element and the vital factors contained in these tissues.

STATISTICS OF INDIAN WHEAT PRODUCTION.—The importance of the application of statistical methods to agricultural problems is exemplified in an article on "Wheat Forecasts in the Punjab" (H. K. Trevaskis, *Agric. Journ., India*, xix. Part III.) Originally crop statistics were based on the requirements of the land-revenue system, but the abnormal conditions created during and after the War led to the development of statistical methods of estimating whether the stocks of wheat in hand were sufficient to feed the great Indian population. At the present time the Punjab wheat statistics, with their bearing on the possibility of export, are of direct importance to the Liverpool wheat market. Forecasts are prepared, of which the first two deal only with the area covered by wheat and cotton, and the last two are estimates of the quantity of the crop actually to be handled. The various methods of estimation of crop yield are discussed, together with the statistical possibilities of estimating the amount required for home consumption. It is suggested that if a census of the stocks in hand could be made at the end of the financial year, it would be increasingly possible to estimate the accuracy of the figures for crop yield and consumption, thus providing more trustworthy data to be considered in controlling the disposal of the wheat crop.

NIGERIAN COAL MEASURES.—Bulletin No. 6 of the Geological Survey of Nigeria deals with the Nigerian Coalfields Section 1, Enugu Area, is by A. D. N. Bain, with appendices by R. Bullen Newton and Prof. A. C. Seward (London: Crown Agents for the Colonies, 1924. 10s. net.) It shows that there are a considerable number of thin seams, but in most of the localities there is a seam of 5 ft. to 6 ft. in thickness, which is evidently workable. A number of analyses are given, showing that the coal is a non-caking coal fairly high in volatile matter and with only moderate ash contents. It is, however, possible that some of these coals may be found to produce a useful coke under suitable conditions. Apparently the coal is a good flaming coal and, therefore, well suited to reverberatory furnace work, so that it would appear to be quite possible to smelt locally the tin-stone produced. The total output in 1922 is given as 110,785 tons, and it is shown that the development of collieries in this portion of West Africa is likely to be of very considerable economic importance.

COMPUTATION OF ESTUARY TIDES.—A paper entitled "Estuary tides: a comparison of methods of computation," by Dr. Bell Dawson, the Superintendent of the Tidal and Current Survey of Canada, is given in No. 41 of the Bulletin of the National Research Council, Washington. The subject under discussion is the accuracy of prediction of the times of high- and low-water at stations where the tides are much affected by the presence of shallow water, as at Quebec. The mechanical harmonic prediction as hitherto used for Quebec, though based on the analysis of 19 years' records, gives average errors in high- and low-water times of 26 and 10 minutes respectively. For Father Point, a station 180 miles nearer the ocean, the predictions are similarly based on 15 years' records, and the corresponding average errors are each 6 minutes. To improve on the predictions for Quebec, Dr. Dawson has applied his principle of variable differences, periodic (though not in general harmonic) in the synodic, anomalistic and declinational months. This is a principle which he has used extensively for many years to deduce tidal predictions at a large number of stations from the harmonic predictions for a small number of standard ports. In his present investigation, he regards Quebec as a secondary port having Father Point for its standard, whereas previously Quebec had been regarded as a standard port. By this means the average errors in the predicted times of high- and low-water at Quebec are reduced to practically the same as those for Father Point.

IONISATION IN SOLUTIONS.—In recent years the view has been expressed by several investigators that strong electrolytes are practically completely ionised even at moderate concentrations, and that variations usually put down to varying ionisation are due to varying activities of the free ions. Attempts have been made by Milner to relate the activity to the electrostatic forces between the ions, and, more recently, by Debye and Hückel. In the May number of the Journal of the American Chemical Society Prof. A. A. Noyes gives an elementary deduction of the formulæ, and a comparison with experiment. The

individual behaviour of different ions, in contradiction to the theory, again emerges, but the general agreement is of a very striking character.

ATMOSPHERIC POLLUTION.—In addition to the completed results published in the annual report of the Advisory Committee on Atmospheric Pollution, arrangements have been made for the circulation, month by month, of abstracts showing the records from deposit gauges, so that earlier information can be obtained. The results for April, according to the *Meteorological Magazine* for June, show that in the centre of Liverpool the deposit amounted to 34 gm. per square metre, while on the outskirts of Southport the deposit was only 2 gm. per square metre In the City of London it was 13½ gm. per square metre. Abstracts can be obtained from the Atmospheric Pollution Committee, 47 Victoria Street, S.W.1.

A NEW SOURCE OF SHORT ELECTRIC WAVES.—The second pamphlet issued by the State Electrical Research Institute, Moscow, is an account by Mrs. A. A. Glagolewa-Arkadiewa of a new method of producing short electrical waves ranging from 0·125 mm. to 50 mm. in length according to the materials used (see also NATURE, May 3, p. 640). This range includes the wave-lengths 2-4 mm. recently produced by Nichols and Tear (*Physical Review*, vol. 2, 1923), and covers the gap between them and the longest produced by Rubens and Baeyer, 0·2-0·34 mm., a dozen years ago by the method of residual radiation. The new method consists in interposing in the spark-gap of the exciting induction coil a paste of fine aluminium or brass particles mixed with heavy machine oil which is carried on the rim of a wheel like a rubber tyre. The wheel dips into a tank of the paste, and by its revolution the paste in the spark-gap is continually renewed. The waves sent out have sufficient energy to allow their wave-lengths to be measured by the mirror method of Boltzmann.

ESTIMATION OF RADIOACTIVE SUBSTANCE BY γ-RAYS.—Dr W. Bothe describes, in the *Zeitschrift für Physik* for May, observations made at the Reichsanstalt with an apparatus in which varying thicknesses of lead, in the form of a series of concentric hollow cylinders with a total thickness of 11·0 cm., can be interposed between the preparation, which is placed in the axis of the smallest cylinder, and the ionisation chamber. This is a cylindrical sheet iron vessel, with a central cylindrical hollow space having the same radius as the largest lead cylinder, which fits into it. The inner electrode of the chamber is a cylindrical ring of sheet iron concentric with the lead cylinders, and is connected with a gold leaf electroscope on the top of the chamber. The arrangement is very sensitive, so that good readings can be obtained with the full thickness of lead. The absorption coefficients of the γ-rays from the substances to be investigated, in equilibrium with their disintegration products, are 0·50 cm.$^{-1}$ for radium, 0·62 cm.$^{-1}$ for mesothorium, and 0·46 cm.$^{-1}$ for radiothorium; so that it is possible for a mixture of the last two to behave like pure radium, and it might be concluded that it is impossible to distinguish between these two cases by the absorption method. Curves have, however, been prepared, showing the relation between the radium equivalent for the pure substances, and for different mixtures, and the varying thicknesses of the lead filter; in these the "normal value" of the preparation, obtained through 0·5 cm. of lead, was taken as unity. The curves show that it is possible to estimate the amounts of the constituents in any mixture of two of these substances, since even with a mixture of mesothorium and radiothorium, in which the absorption is "equal" to that of radium, the curve is not identical with that of radium, but cuts it at three points, and is easily distinguished from it. Such a mixture together with radium may give a curve from which it is impossible to deduce the relative amounts of the three constituents; but, apart from this, the composition of any mixture of these substances can be estimated from its curve.

WASTE HEAT BOILERS AND VERTICAL RETORT GAS INSTALLATIONS.—Results of tests carried out by the Gas Investigation Committee of the Institution of Gas Engineers at the works of the Birmingham Gas Department, and embodied in the twelfth Report submitted by the Committee to the annual meeting of the Institution, show that by the introduction of the practice of heat-recovery from waste gases in waste heat boilers the thermal efficiency of gas production in normal working with continuous vertical retorts is increased from 60 per cent. to about 66 per cent.

PULVERISED FUEL.—A paper on "Pulverised Fuel and Efficient Steam Generation" read by Mr. D. Brownlie before the Institution of Electrical Engineers last December has already been noticed in NATURE, January 12, p. 62. The paper in full with the discussions which have followed at various centres appears in the Institution's Journal for May. These are interesting because the subject of the relative merits of mechanical stoking and pulverised fuel firing is to-day very controversial and was extensively debated by many speakers. Furthermore, the paper dealt with a single system using a central pulverising plant, and there were a number of advocates of systems employing "unit pulverisers" to each furnace Again the possibility that the ejection of coal ash would cause a dust nuisance in the densely populated areas of Great Britain aroused much concern. It was urged in reply that this dust is so fine as to be carried far away from the installation so that its final destination is unknown.

PRODUCTION OF TOWNS' GAS BY THE REGENERATIVE GASIFICATION SYSTEM.—A plant for the production of towns' gas from coal by the regenerative complete gasification system introduced by Messrs. M. W. Travers and Clark, has been in operation at Aylesbury since February 1923, and was described at the annual meeting of the Institution of Gas Engineers The installation has about three times the output of a carburetted water gas plant which previously occupied the site on which it has been erected. Coal is carbonised in an upper section of the plant by internal heating effected by direct transference of heat from hot gases passed through the coal. The resulting coke is gasified by the alternate action of steam and air in the lower section of the generator. Heat is recovered from the blow gas in a regenerator, from which the heated circulating gas passes to mix with the water-gas passing from the lower to the upper section of the plant during the run. The output of gas from the plant is approximately 184 therms of gas of calorific power about 360 B.Th.U. per cubic foot per ton of dry coal gasified. By carburetting, the calorific power of the gas is raised to 420 B.Th.U. per cubic foot. The overall efficiency of the complete gasification process is 55·3 per cent., which compares favourably with an estimated efficiency of about 46·7 per cent characterising the more usual practice consisting of a combination of a carbonisation process with the production of water gas. Operating charges, excluding cost of coal but including costs of carburetting and purification, amount to 1·39*d*. per therm delivered into the gasholder.

Relativity at the International Congress of Philosophy, Naples.

SINCE the inception of the International Congresses of Philosophy in 1900, it was arranged that such gatherings should be an opportunity for philosophers and men of science to meet on common ground for discussion. Nowadays, philosophers cannot claim to have a complete system unless they account for the various branches of science in their synthetic explanation of things. They must understand what men of science have found out for themselves and give a value to their discoveries in their theories of knowledge. It is quite appropriate then that they should be helped in their efforts by the searching analysis scientific workers have made of their own labours. There cannot be any antagonism between philosophy and science; one completes the other and each is strengthened by the support of the other.

It was a gratifying spectacle to see metaphysicians, logicians, mathematicians, physicists, and biologists sitting together in the great halls of the University of Naples. These meetings formed an integral part of the International Congress of Philosophy, which was arranged at Naples at the beginning of May, under the presidency of Prof. Aliotta, on the occasion of the seventh centenary of the foundation of that University.

Unavoidably the outstanding question under discussion during these joint meetings was Einstein's theory of relativity. Prof Einstein was, however, prevented from attending the Congress at the last moment. Nevertheless, some valuable papers were read at the sittings of the section of History and Philosophy of Science. Under the chairmanship of Prof. Marcolongo of Naples and then of Prof. Hadamard of Paris, various aspects of the theory of relativity were developed. Prof. Cartan (Paris), in a paper on "The Theory of Relativity and the Generalisation of the Notion of Space," gave an interpretation of Einstein's tensor by means of the notion of curvature and that of the torsion of a curved space, using also Levi-Civita's definition of parallelism. Prof. Hadamard put forward some interesting considerations on the equations of cylindric waves already studied by Volterra. M. Nordmann, of the National Observatory of Paris, dealt with the controversy between Einstein and Bergson with reference to the relativity of time. He contended that Einstein's memoir, published in 1905, gives no ground for criticism, and that Bergson's remarks are based on certain statements, made by Einstein in his popular work, which are open to controversy.

Mr. Zaremba of Cracow, in a paper, "The Theory of Relativity and Experience," pointed out some logical failures of Einstein's theory, and expressed the opinion that at the present stage it cannot be said that experience is for or against it. Prof Kopff (Berlin) developed some suggestive relations between astronomy and Einstein's conceptions.

Prof. Enriques (Rome), in a paper entitled "A Criticism of the Notion of Time," maintained that time is not only, as according to Kant, the order of internal sensibility, but also that it contains the idea of a natural standard of measure. The analysis of the postulates referring to such a standard reveals the unity of physical forces and the hypothesis that time is independent of space. The rejection of this hypothesis leads to the theory of relativity. Prof. Giorgi acknowledged that the mathematical and logical structure of Einstein's theory is absolutely perfect and quite compatible with natural phenomena. But he does not think that this theory has had sufficient verifications in proportion to its importance and ambitions. Prof. Severi expounded a new method of arriving at Lorentz's classical formulæ by means of an analysis of the concept of time. Prof Timpanaro, speaking on "The Value of the Theory of Relativity," proposed a new theory, which he called etheral-ballistic, according to which natural phenomena can be explained with as much exactness as with the theory of relativity.

The great opponent of Einstein's ideas was Prof. La Rosa, of Palermo, who spoke on "Some Astronomical Facts against Einstein's Theory based on Ritz's Hypothesis." He showed how to explain several phenomena of variable stars according to Ritz's hypothesis where the velocity of light is compounded with that of force Einstein's theory, he said, is only one of the possible relativistic ways of interpreting natural phenomena. There is, besides, what he called the "ballistic method," which has much experimental evidence in its favour. The ballistic hypothesis states that the velocity of light can be compounded with that of its source; and when applied to the theory of the double stars it leads to some very interesting and unexpected results. For example, on the basis of the ballistic hypothesis, all double stars having a distance and a period satisfying certain limitations, must appear to us as variable stars. Following up this line of thought, Prof. La Rosa offers a general explanation of the phenomena of double and variable stars

Among other papers on the philosophy of science, we must mention those of Prof. Vorovka (Prague) and Sittignani, who discussed from different angles Poincaré's epistemological theories, and Prof. Driesch's communication on "The Philosophy of Organic Life." Prof. Hans Driesch, the most authoritative representative of vitalism, explained, with an abundance of examples, that the phenomena of life cannot be accounted for simply by means of physico-chemical processes. Biology shows us that a multicellular organism can be divided up into many parts without stopping its development. A machine cannot be submitted to the same operation with the same results. There must be, therefore, in every living organism a cohesive agent, which he calls "entelechy," the function of which cannot be analysed at the present stage of science, but obviously it causes the organism to develop whatever be the mishaps it may suffer.

In his paper on "The Specification of the Straight Line," Dr. T. Greenwood developed the logical arguments which lead him to state in a new way the problem of the characterisation of the Euclidian straight line by means of a single axiom which he calls "The Postulate of Null-Curvature." He establishes this postulate by means of a new hypothetico-deductive system of axioms based on the notions of "point" and "distance," and uses it to prove the two ordinary postulates of the straight line. This method, which is very simple in itself, has many advantages in the logical, the pedagogical, and the scientific field.

The numerous papers, more than two hundred, read at the Naples Congress did not permit of any discussion, mainly because the time available was not proportionate to their number. This, however, shows admirably the passionate devotion with which Italian thinkers study science and philosophy, and the more so as, besides the International Congress of Philosophy, an Ophthalmological Congress, a Gynæcological Congress, and a joint meeting of the Association of Scientific Societies of Italy, were sitting concurrently at Naples, whilst there was a Sociological Congress and a Eugenics Congress at Rome, and a Geographical Congress at Genoa. Yet, to all those who were able to go to Naples—unfortunately there were not many visitors from Great Britain—the visit will rank among the most pleasant memories of their academical career.

THOMAS GREENWOOD.

The National Physical Laboratory, Teddington.

ANNUAL INSPECTION.

On Tuesday, June 24, the General Board of the National Physical Laboratory made the annual visitation to the Laboratory. As is usual on this occasion, a large number of members of scientific and technical societies and institutions, members of Government departments and of industrial organisations were also invited to the Laboratory, the whole of which was open for inspection. The visitors were received by Sir Charles Sherrington, chairman of the General Board, Sir Arthur Schuster, chairman of the Executive Committee, and the Director of the Laboratory.

An extensive programme of exhibits had been arranged to illustrate the general character of the work of the Laboratory in addition to features of particular or novel interest.

In the Aeronautics Department the wind channels were shown in operation on various problems which are engaging the attention of the Department In the 7 ft. wind channel, the airflow round a monoplane aerofoil was being investigated with the object of examining the fundamental assumptions of the Prandtl theory of vortex motion. Special hot wire anemometers, in which the wires are placed along instead of across the air stream, are used to observe the direction and velocity of the air stream The existence of eddies behind cylinders in an air stream was made evident audibly, by the amplification in a two-valve amplifier and telephone receiver, of the fluctuating potential differences produced by the cooling effects of the eddies, in a hot platinum wire placed behind the cylinder. In the 14 ft channel, apparatus was on view designed and constructed in the Department for measuring the head resistance of stream line bodies in a wind channel and in the William Froude National Tank. By using the same apparatus in both air and water, the method eliminates the interference between the apparatus and the body under test, so that comparison of the results is possible, and for the first time accurate deductions of the importance of "eddies" in channel work can be made. Other exhibits included the whirling arm and the electrical method of determining the theoretical stream lines for an inviscid fluid moving past a flat plate, both of which were mentioned in the description of the exhibits at the last visitation

In the Engineering Department, a special electrical dynamometer designed to produce full torque from 20-1700 revolutions per minute was exhibited. The field magnet frame was mounted on roller bearings, and it is claimed that the power transmitted (up to 100 h.p.) is measured to one-tenth of 1 per cent. Another interesting exhibit was that of apparatus for measuring and recording the relative movement of chassis and axles in vehicles This work has developed in connexion with a general research on springs for vehicle suspension The effect of shock absorbers in damping vibrations has also been investigated. Apparatus for determining the effect of keys and keyways on the endurance of shafts and for testing brake lining materials was also on view

In the Metallurgy Department a high frequency induction furnace was shown in which metals can be melted in vacuo without danger of contamination from circumambient gases The electrolytic preparation of iron and chromium of 99·98 per cent. purity was also on view. In the Wernher Building, interesting microphotographs showed the behaviour of mild steel and brass under the action of cutting tools. These indicated the great importance of the orientation and shape of the tool in determining the ease with which the metal is cut, the character of the finished surface and the wear on the tool.

In the William Froude National Tank a model 10-knot single-screw cargo steamer was shown under test for propulsive efficiency. The thrust and torque of the propeller and the resistance of the hull in water are measured. The plant for making accurate models of ship hulls of a mixture of paraffin wax and beeswax, and also of screw propellers, was on view, and a model propeller was shown under construction.

In the Metrology Department standard weights, including new weights made of stellite, were shown. Various measuring machines designed and constructed in the Department were also on view. These included the "millionth" comparator and tilting level comparator for the comparison of standard length gauges to an accuracy of a millionth of an inch, an improved travelling microscope and the Blythswood diffraction grating ruling engine Various methods of the application of interferometry to metrological work were shown together with sources of light producing a series of monochromatic rays covering a wide range in wave-length

A very large number of exhibits was shown in the Physics Department, including a new form of all-metal mercury vapour pump, capable of extremely rapid exhaustion, and a standard optical pyrometer of the disappearing filament type for use up to 3000° A. The most interesting were in connexion with the sound section, in which a photographic method of studying the acoustical properties of rooms was shown A vertical section of a model of a building was placed horizontally in a trough of water, and trains of water waves were emitted from a point corresponding to the position of a speaker. By projecting light vertically through the glass bottom of the tank, the shadow picture of the disturbance at the surface of the water could be seen on a screen above This was photographed at certain definite times, enabling the progress of any wave to be followed in its travel across the model of the room, and in its reflections (echoes) from the walls or architectural details. The results have shown in a very convincing manner how in buildings the structural details can interfere with the propagation of speech in certain parts, and the department has been able to make valuable suggestions to improve the acoustical properties. Experimental sounds are very often produced by electrical methods, and an interesting method of study of the purity of the waveforms of electrical oscillations, which are later transformed into auditory oscillations, has been developed. It involves the use of the Weston cathode ray oscillograph, the spot of which describes a circle on the fluorescent screen if the oscillations are sinusoidal

The Radiology Section exhibited apparatus for the determination of absorption co-efficients, using a metal X-ray tube of high output, for the rapid determination of the lead equivalent of X-ray protective material, and various apparatus for the determination of the crystalline structure of metals and alloys, several of which have been worked out and are of great interest in connexion with the collateral work of the Metallurgy Department on the same alloys. In the Optics Section a new flicker photometer for comparing lights of different colours and improved spectrophotometric apparatus were shown. A constant temperature room has been added to the equipment of this section since the occasion of the last annual visitation and should result in the eventual determination of important optical constants to a greater accuracy than has been possible hitherto. The room is cooled by air from a refrigerat-

ing plant or warmed by air passing over electric heaters; cooling or warming to any desired temperature is automatic through electrical resistance thermometers and relays, and maintains the temperature at any point constant to 0·01° C.

In the Electricity Department, Alternating Current Division, the arrangements for the accurate measurement and calibration of A.C. instruments and of high voltage insulating materials were shown. An interesting phenomenon in dielectric hysteresis was exhibited in which a rotating electric field caused a cylinder of celluloid to rotate. The greater the energy loss due to imperfection of insulation quality, the greater is the torque and the speed at which the insulation material will rotate, except that owing to friction the speed cannot reach that of the rotating field (50 r p.m.). In the Direct Current Division the association of a hydraulic pressure with endosmosis was exhibited. An electric circuit of 100 volts was earthed under a glass funnel full of damp earth surrounded by water. In the experiment shown, the passage of a few milliamperes caused the water to ascend from the earth to a height of 12 ft. in a tube connected to the funnel. The phenomenon is of interest and importance in the choice of the most suitable methods of earthing electrical machinery and power cables.

The Photometry Division showed exhibits illustrative of the careful work and research which is contributing to the improvement of artificial illumination of all kinds. The experimental building for determining the best methods of utilising daylight was also shown in operation, and a new instrument for measuring daylight factors shown. In the Electrical Measurements Division apparatus showing the accuracy which has been developed in the measurement of frequency in radio oscillations was exhibited. A radio station for the transmission of standardised frequency has been equipped and was open for inspection. In the Wireless Division, apparatus was shown which enables the direction of both the electric and magnetic forces in electromagnetic waves to be determined separately, so that the direction of the wave front is accurately known. This is of interest in connexion with the Beveridge antenna, the action of which is due to the existence of tilt in arriving electromagnetic waves. Among the standard testing apparatus demonstrated were a panel for measuring all the static characteristics of receiving valves, and a set for examining the amplifying properties of audio frequency intervalve transformers. In the latter arrangement the actual voltage amplification produced by a stage comprising one valve and one transformer is measured by a comparative audibility method at any frequency from 250-4000 cycles per second Using standard types of amplifying valves this measurement enables a study to be made of the frequency distortion introduced into speech-frequency amplifiers by the iron cored intervalve transformers. Other apparatus was shown by which the input and output of any standard type of amplifying detector can be measured, thus enabling a complete study to be made of the behaviour of an amplifier at either radio or audio-frequencies. H. B.

The Natural Resources of Russia.

THE Transactions of the Committee for the Study of Russia's Natural Resources, attached to the Russian Academy of Science, include works of varying type:

(1) Separate monographs—"Precious Stones of Russia," by A. E. Fersman; "A Household Fungus," by I. A. Makrinoff.

(2) Studies of Russia's natural resources—"Russian Wax," by N. M. Koulagin; "Medicinal and Tanin-producing Plants of the Tavricheskaya Province," by B. N. Lioubimenko; "Tea and its Cultivation in Russia," by the same author; "Kendyr (Apocynum Sibiricum Pall)," by I. A. Rajkova; "Russian Sources of Fuller's-earth," by A. E. Fersman; "Beet," by E. V. Kostezky and E J. Zalensky; "Iodine Containing Lakes of the South of Russia: Eltonskoe, Bakou Iodine Lakes and the Saki Lakes," by N. N. Efremoff, G. G. Ourazoff, and A. E. Fersman; "Bozon," by V. G. Khlopin; "Absorbing Properties of Russian Clays," by P. E. Zamiatchensky, "The Caspian Pilchard," by B. I. Meisner; "Phosphates of the Ukrain," by V. N. Chervinsky; "Tihvin Bauxite," by A. D. Stopkevitch, V. I. Ikskul, and B. P. Ovsiannikoff; "Honey," by I. A. Kabloukoff; "Mica," by I I. Ginsbourg.

(3) Periodicals—vol. 1 of "Wind as Driving Power," by M. M. Rikacheff, A. V. Voznesensky, and T. N. Klado; vol. iv. of "Useful Ores," including: "Silver, Lead and Zinc," by K. I. Bogdanovich, "Gold," by K. I. Bogdanovich, "Vanadium," by K. I. Bogdanovich and K. A. Nenadkevich; "Sulphuric Pyrite," by J. B. Samoiloff; "Russian Coals," with an introduction by P. I. Stepanoff—a co-operative work of 30 specialists of the different coal regions of Russia; "Naphtha and Ozokerite," by D. B Goloubjatnikoff; "Phosphates," by J. B. Samoiloff and A. D. Arhangelsky; "Felspar," by A. E. Fersman; "Ores of Aluminium," by K. K. fon Foht; "Selenium," by F. B Bragalia; vol. vi. of "The Animal Kingdom": "Mammals and Birds," by A. A. Silantieff and E. K. Souvorov; "Fishes," by V. I. Meisner, N. M. Knipovich, V. K. Soldatoff, I. N. Arnold, I. D. Kouznezoff, A. I. Golovkin, and A. J. Nedoshivin, "Cattle," by S. A. Ivanoff; "Poultry," by M. I. Diakoff.

(4) Reports on the Activities of the Committee: Minutes xxvii.-xxxiii., reports on 1918 and also reports from 1915 to 1920; and

(5) News from the different scientific institutions attached to the Committee: Institute for the Study of Platinum and other Rare Metals, Institute of Physico-Chemical Analysis.

All the above-mentioned bulky and valuable material in connexion with the natural resources of Russia has been published since 1918–1920. With exceptional feeling and respect one turns over these pages, written by Russian men of science, with a great love of their country, and in circumstances of the greatest privations. These privations affected not only their personal well-being, but also such things as the possibility of getting necessary scientific literature and reagents, and even the temperature of the laboratories. We can get an idea of the hardships they endure by occasional phrases we sometimes meet in their works. We learn, for example, that the temperature of the laboratory of the Polytechnical Institute in Petrograd was the same as that of the street, because the laboratory could not be heated; that the photographic section of the expedition for exploring the Karabougai Gulf could only make negatives because they had no suitable printing paper and equipment to be able to make use of silver bromide paper, etc. In spite of, or perhaps even because of these awful surroundings, Russian men of science have devoted themselves with praiseworthy neglect of self to their scientific work.

"In the dark and even perhaps seemingly hopeless days of Russian everyday life, I have tried," says

Prof. Fersman in the introduction to his book on "The Precious Stones of Russia," "to fly away into the world of the beautiful stone. I want to carry away my friends and the friends of stones from the heartrending surroundings of their everyday life, into another world, and in a number of talks I have tried to show the riches of Russia in her precious stones."

At the head of this Committee there stands a Council of the most prominent men of science. The president of the Council is a member of the Academy—Prof. V. I. Vernadsky—while another member is N. S. Kournakoff, vice-president. The Committee was founded by the Russian Academy of Science in 1915. As Russia during the War was cut off from the world's market, it had to make use of its own resources, and increased knowledge of these natural resources became necessary.

M. Vernadsky expressed this idea in the following words in 1915: "We are in such a position as regards a whole number of our natural products, that we even do not know if we have them, and if we have got them, then in what quantities—all this is because we have got used to getting them from abroad and have given up looking for them in our own country." Russia, therefore, needed a systematic survey of its natural resources in order to become self-supporting. The problem of developing the natural resources has been put forward by the Committee ever since as a great national goal.

The author of the project of founding a special institute for the geographical study of Russia, A. A. Gavriloff, says in May 1919, "The world's economy must pass through an epoch of highly organised national economies, in which the highest possible organisation of production and useful development of the natural resources of the country reduce to a minimum the competition between the different undertakings within the country. In this way is obtained increased economic strength and means for productive competition with other nations. It is only natural that Russia must needs follow along this path."

The Committee of the Academy of Science has rendered a great service to Russia by collecting and systematising so much material in connexion with the natural resources of Russia. Since 1915 to 1920 it has published 13,469 pages of scientific works. This Committee has likewise rendered a service to world economy; every foreigner who wants to take to Russia his capital or his knowledge for the development of Russia's natural resources will find in these works clear and definite answers to the questions which interest him in connexion with different branches of industry.

Limitations of space forbid a detailed account of the works mentioned above. Special attention may be directed, however, to the brilliant work of Prof. Fersman on the precious stones of Russia, and to works with most detailed and careful information on Russian coal, naphtha, platinum, and gold. Attention may also be directed to the energetic action of the Committee in supporting new industries started in Russia before the War began, such as the production of radium and vanadium from the Tuja-Mujunski mines Before the War this was undertaken and carried out by the Fergan Society of Rare Metals. With the nationalisation of the mines this young undertaking might otherwise have been killed.

The Committee for the Study of Russia's Natural Resources has formed a special section in connexion with rare metals and radioactive substances. This includes such prominent men of science as Vernadsky and Kournakoff, both of whom are members of the Academy, and Profs. Jakovkin, Joffe, Veber, Sokoloff, Lialin, and Khlopin. What is even more, this section has obtained a Government grant, and has started works in connexion with the production of radium. Information relating to this interesting section of the work of the Committee will be found in the Transactions of the Committee of the Academy of Science for 1918.

The Geological History of South-Eastern Australia, with Special Reference to the Carboniferous and Permian Periods.[1]

By C. A. SUSSMILCH.

ROCKS of definite Archæozoic age occur only over a limited area in the western part of south-eastern Australia; they contain the important silver-lead-zinc ore-deposits of the Broken Hill District. Proterozoic strata are limited also to the same area; these contain glacial tillites which have usually in the past been considered Cambrian, but they are probably of pre-Cambrian age. No undoubted Cambrian strata are known to occur in New South Wales.

Ordovician strata are very extensively developed, both in New South Wales and in Victoria: they consist mainly of claystones with some fine-grained sandstones, and contain an abundant graptolite-fauna. Both Lower and Upper Ordovician strata are found in Victoria, but so far only the latter have been identified in New South Wales. Silurian strata are developed over extensive areas in New South Wales, particularly in the southern and central parts of the State, and extend also through the centre of Victoria, in addition to claystones, there is a considerable development of limestones, individual beds ranging up to 550 feet in thickness. An abundant coralline fauna is preserved in these limestones and there are also many brachiopods and hydrozoa.

The sea appears to have retreated from the land at the close of the Silurian Period in south-eastern Australia, but renewed transgressions of limited extent took place early in the Devonian Period. The sedimentation which took place in these areas in Lower and Middle Devonian times was accompanied by very extensive deposition of lavas and tuffs, this being one of the important volcanic epochs of south-eastern Australia Thick coralline limestones were also deposited during that age. Important crustal movements took place at the close of the Middle Devonian times, followed by an extensive transgression of the sea in New South Wales in the Upper Devonian Period, a transgression which extended from the present south-eastern coast almost to the far western boundaries of the State. In the strata deposited in this epicontinental sea an abundant brachiopod fauna is preserved, together with numerous fish-remains. Important crustal movements took place at the end of the Devonian Period, which brought about a complete withdrawal of the sea; much of south-eastern Australia has not since been beneath the sea.

Early in the Carboniferous Period a geosyncline developed in north-eastern New South Wales, and in this was first deposited a series of marine strata in

[1] Substance of a lecture delivered before the Geological Society of London on May 21.

the latter part of Lower Carboniferous times. Following a withdrawal of the sea, an extensive series of terrestrial beds was deposited in this area in Middle and Upper Carboniferous times, these terrestrial strata consist mainly of conglomerates, volcanic rocks (lavas and tuffs), and glacial beds, of an aggregate thickness approaching 10,000 feet. The glacial beds are of such a thickness and volume as to imply intense and long-continued glaciation. Associated with these beds is a characteristic Rhacopteris fossil flora.

In Permian (Permo-Carboniferous) time an alternating series of marine and freshwater beds was deposited in the north-eastern part of New South Wales, and these extend far northwards into eastern Queensland The freshwater beds contain the most productive coal-measures of Australia, and associated with the coal-seams is the characteristic Glossopteris flora. The glacial conditions of the Carboniferous Period continued also far into the Permian Period, but with apparently reduced intensity. The Permian Period closed in north-eastern New South Wales and south-eastern Queensland with pronounced orogenic movements, accompanied by granitic intrusions; but elsewhere in New South Wales and throughout Victoria and Tasmania, no earth-folding took place at that time.

In the Trias-Jura Period the whole of eastern Australia stood above the sea, and extended far east of the present shore-line. Upon this land there developed a number of large lake-basins in which several thousands of feet of freshwater strata were deposited, and in some areas productive coal-measures were formed In the Cretaceous Period a transgression of the sea began in the north, and extended southwards over central Queensland into northern New South Wales, and well into central Australia. At the beginning of the Tertiary Period a tilting of the Australian continent on an east-and-west axis caused the Cretaceous sea to retreat northwards, and allowed of transgression taking place over considerable areas in the south, incidentally separating Tasmania from the mainland.

The close of the Tertiary Period was marked by a great epeirogenic uplift in eastern Australia, which produced the existing tablelands trending parallel to the eastern coast of Australia. The elevation of these tablelands was accompanied by extensive block-faulting. During the Pleistocene Period, limited high areas in New South Wales and Tasmania supported glaciers and ice-sheets; more recently, a subsidence of the land (or raising of sea-level) drowned the shore-line to an extent of about 200 feet, and still later an upward movement of the strand-line of some 10 to 20 feet has taken place.

The Japanese Earthquake of September 1, 1923.

SHORTLY after the Japanese earthquake of September 1, 1923, Mr. Takeo Kato, on behalf of the Imperial Earthquake Investigation Committee, made reconnaissances through the districts of violent shocks, especially those around Sagami Bay. He has published a preliminary report on this field study in the Journal of the Geological Society of Tokyo (vol. 30, No. 361), including some definite estimates of the loss of life and property. In Tokyo, though not a house escaped some damage, the number of houses that collapsed owing to the shock was comparatively small The latest official statistics place the number of houses destroyed by fire in Tokyo at 316,087, the number of killed at 67,052, of injured at 32,583, and of missing at 38,980. The shocks were far stronger at Yokohama, and strongest of all in the districts around Sagami Bay. In six towns along and near the borders of the Bay, 84,300 houses were destroyed and 26,370 lives were lost.

From seismographic and other evidence, the epicentre of the great earthquake seems to lie in Sagami Bay, about midway between Oshima and Hiratsuka, near the mouth of the Sagami River, and probably a little nearer the latter place. In the two months following this shock, the number of after-shocks was more than 1350; there were 365 on September 1, and 289, 173, and 143 during the next three days; afterwards the normal decline in frequency was manifested. The epicentres of these after-shocks lay at different places more or less remote from the main one. A few minutes after the great earthquake sea-waves swamped the shores of Sagami Bay, from Shimoda in the Idzu peninsula to Misaki and Uraga in the Miura peninsula, and also along the southern part of the Boso peninsula. They caused much damage only at Ito, Atami, Kamakura, and a few other places, where the height of the waves ranged from 20 to 40 feet. No conspicuous sea-waves were seen in Tokyo Bay. No great fault-scarps or traces have been observed, but in the islet of Hatsu-shima, off Atami, a fissure was traced for about half a mile, with in some places a displacement of 3 feet or more, running in the direction N. 30° W. Another, rather more than a mile in length, was found near Nagasawa in the Miura peninsula. Both fissures may be regarded as minor faults of the main fault along which the great earthquake originated.

A remarkable upheaval of the ground took place, it is said, within a few minutes after this earthquake, over an area of about 2000 square miles, including the islet of Hatsu-shima, the headland of Manazuru, the northern border of Sagami Bay, the Miura and Boso peninsulas. The greatest upheaval (about 8 feet) occurred at Tomizaki, along the southern coast of the Boso peninsula, and it is remarkable that here the ground settled down more than a foot within one month after the upheaval. According to the soundings made by the Navy Hydrographic Office, conspicuous changes in depth, of 50 fathoms and more, have occurred at various places in the deepest portion of Sagami Bay. Soundings are still being carried out in the Bay, while many levelling parties of the Military Department are engaged in ascertaining the changes in elevation throughout the earthquake area.

It is worthy of notice that the epicentre lies in the deepest region of Sagami Bay. This trough, which has a N.N.W. direction from Oshima to Hiratsuka, appears to be the southern continuation of the valley of the Sagami River running in the same direction. Moreover, tectonic lines in this direction are numerous, as indicated by the coast borders, valley courses, etc., and the minor faults at Hatsu-shima and Nagasawa run nearly parallel to this direction. The origin of the earthquake is attributed to a great compressive force, probably from the east, which has been accumulating for a long time. The last great earthquake in the district occurred on November 22, 1703, and seems to have originated in a great fault along the same tectonic line, the epicentre lying apparently a little to the south of that in 1923. A similar upheaval of land is recorded at that time.

C. D.

University and Educational Intelligence.

BIRMINGHAM.—At the annual Degree Congregation held on July 5 the Chancellor (Viscount Cecil of Chelwood) conferred the honorary degree of LL D on His Excellency Count de St. Aulaire, The Rt. Hon. Reginald M'Kenna, Sir Charles Sherrington, Sir John Bland Sutton, Sir Arthur Keith, Sir Henry Fowler, Sir Graham Balfour, Prof. Samuel Alexander, Prof. G. H. Hardy, Prof F. Gowland Hopkins, and Prof. P. F. Frankland.

There were 4 successful candidates for the degree of Ph.D. and 18 for M.Sc In the Honours Schools the degree of B.Sc. was conferred on 3 in mathematics, 8 in physics, 17 in chemistry, 1 in zoology, 3 in botany, 2 in biochemistry, and 26 in engineering, mining, and metallurgy. For the ordinary degree of B Sc, 62 candidates were presented, and for the degrees of M B., Ch.B., 29.

Mr. A W. Nash has been appointed professor in oil mining. Educated as a civil and mechanical engineer, Mr. Nash has had fifteen years' experience in oil mining in Persia, Burma, Egypt, Russia, Hungary, Rumania, and Poland, and for the last two years he has been lecturer in oil mining in the University.

Mr. H. Beckwith Whitehouse has been appointed professor of midwifery and diseases of women. Mr Whitehouse was educated at Malvern College and St. Thomas's Hospital Medical School, and among other posts he has held that of Hunterian professor to the Royal College of Surgeons, England.

Dr James Maclure Smellie has been appointed lecturer in pharmacology and therapeutics; and Mr Bernard G. Goodwin has been appointed assistant to the chair of surgery

Miss Mabel Geraldine Carter has been appointed temporary lecturer in biology.

Some anxiety has been shown in the local press as to the openings available for the graduates in science now leaving the University. Prof G T Morgan, in a letter to the *Birmingham Post* of July 5, directs attention to the fact that graduates of the University find employment more readily in other large towns than in Birmingham itself. Prof Morgan observes that he himself is frequently consulted by local manufacturers in search of advice in chemical problems, and he suggests that many of these inquirers would find it highly advantageous to select a chemical staff of their own from the ranks of trained chemists who are being produced yearly in the University

CAMBRIDGE—Dr. J. Chadwick, Gonville and Caius College, has been appointed Assistant Director of Radioactive Research at the Cavendish Laboratory. Mr. H. Thirkill, Clare College, and Dr. C. D. Ellis, Trinity College, have been appointed demonstrators in experimental physics; Mr. F. W. Dootson, Trinity Hall, Mr. H. M'Combie, King's College, Mr. W. G. Palmer, St. John's College, and Mr A. J. Berry, Downing College, have been appointed demonstrators in chemistry. Mr. J. C. Wallace has been re-elected to a junior fellowship at Emmanuel College. H. E. Baker, Corpus Christi College, has been awarded the Wiltshire Prize. Frank Smart Prizes are awarded to R. G. Tomkins, Trinity College (botany), and to G. P. Wells, Trinity College (zoology).

LEEDS.—Headingley Wesleyan College and its extensive grounds have been acquired by the University, and at the beginning of next session will be opened as a University Hall of Residence for 120 men students.

LONDON.—At a meeting of the board of the Middlesex Hospital on July 2, it was announced that Mr. S. A. Courtauld, for many years a generous supporter of the Middlesex Hospital and its Medical School, has given 20,000*l* to endow the University professorship of anatomy in the Medical School.

IN connexion with the London (Royal Free Hospital) School of Medicine for Women, a 1916 bursary of the annual value of 50*l*. for five years is offered to a student who has matriculated and who wishes to enter the school in October next to begin a full course of study for a medical degree. Particulars of the bursary are obtainable from the Warden and Secretary, 8 Hunter Street, W.C.1.

MR. D. B J. WALLACE, county agricultural organiser for Devon, has been appointed principal of the East Anglian Institute of Agriculture at Chelmsford.

FOLLOWING upon the death of Prof J. G. Longbottom, head of the Department of Mechanics, the Governors of the Royal Technical College, Glasgow, have decided to amalgamate the Departments of Mechanics and Mechanical Engineering under Dr. A. L. Mellanby, who will in future be the professor of mechanics and mechanical engineering. Dr W. Kerr, lecturer in mechanical engineering, has been appointed associate professor in the Department. Dr. Kerr is known for his work on the "Steam Friction of Turbine Wheels" and on the "Critical Speeds of Revolving Shafts," and in collaboration with Prof Mellanby has published numerous papers dealing with problems connected with steam turbines.

THE University of Sydney loses this year the services of Mr H. E. Barff, its Warden and Registrar for forty-two years, who is resigning office on account of ill-health. The abnormal increase in the number of students after the War imposed a severe strain on the administrative staff of the University and on its finances. The report for 1923 shows that the number of students in attendance in that year (2755) and in each of the four preceding years was almost, if not quite, double the number in the last year before the War. Since 1920, however, the number has been decreasing. The Sydney University Union, the oldest society of its kind in Australia, and one that challenges comparison with the Oxford and Cambridge Unions, celebrates this year its jubilee.

THE report of proceedings of the Annual Conference of the Universities of Great Britain and Ireland held in May last has been published by the Universities Bureau, 50 Russell Square, W.C.1 (price 1s.). The subjects discussed are: Directions in which universities might profitably develop, at the present time, were funds available; the Ph.D Degree as an encouragement to higher study and research; universities and research in relation to the development of the natural resources and industries of the Empire; interchange of university teachers and students. We have already, in our issue of May 17, given a summary account of the proceedings. The full report covers 63 pages and includes, in addition to the speeches that were delivered, an important paper embodying the substance of a speech which Sir Frederic L. Nathan intended to make on the dependence of the British Isles and the Empire generally on imports from foreign countries and the steps which should be taken to remedy this. There is also a letter from Sir Robert Robertson, Government Chemist, on the difficulty of finding suitable candidates for posts of chemist and agricultural chemist in the Government laboratories in the Colonies.

Early Science at the Royal Society.

July 6, 1663. Dr. Wilkins undertook to engage Dr. Power to make that magnetical experiment here, which he had made in the country, according to his written account sent to Dr Croune for the society, viz., of altering the polarity of a heated and cooled iron, by repercussing the two ends, and of destroying all the magnetism thereof, by striking such an iron in the middle.

1664. Capt. Taylor related, that he had known a Frenchman, who had a secret of tempering and hardening iron so that it would not rust; adding that the steel of a gun, which he produced, had been put in salt water, and was not affected with any rust; and that the same gun had not been oiled since it had been made, viz., for three years The artist employed a certain water, which he concealed the ingredients of, wherein he quenched the iron eight or ten times, in order to reduce it to this condition

July 8, 1663. Dr. Charleton presented the society with the plan of the stone antiquity at Avebury, near Marlborough, in Wiltshire, suggesting that it was worth the while to dig there under a certain triangular stone, where he conceived would be found a monument of some Danish king Col Long and Mr. Aubrey were desired to make farther enquiry into it.

1675. Mr. Hooke shewed an experiment concerning the resistance of air to a ball moved with and without an expanded area; of which he was desired to bring in a particular account in writing.

1685. A letter of Mr. Musgrave dated at Oxford, July 4, 1685, was read, mentioning, that a great part of the university being in arms [On occasion of the Monmouth rebellion] the Philosophical Society there was broken up for some time.

July 10, 1672. The Society intending to make a recess for some time, the members were desired, that as many of them, as could conveniently, would meet on Fridays in the afternoon at Gresham-college, to discourse of philosophical matters, and prosecute experiments; among which were recommended—Such, as might determine the queries lately sent by Mr. Newton, which involve his theory of light.—Such, as might improve Mr. Newton's reflecting telescope; and particularly to see finished a four-foot telescope of that kind, already recommended to Mr. Cock.—Such observations as might confirm those of Signor Malpighi about the existence of certain tracheæ, or spiral fibres in vegetables, that contain air: as also to endeavour to the finding out of peristaltic motion, affirmed.

1679. Divers discourses were occasioned about the several ways of tanning leather.

July 11, 1666. Dr. Croune produced a letter, written by Nicholas Stens, from Rome, mentioning the emulation between Divini and Campani about optic glasses. That Campani had been mistaken in some of his observations, taking the spots adhering to the body of Jupiter for the shadows of his satellites.

1667. Mr. Hooke reported that Dr. Croune had received from Mr. Richard Townley, Mr Gascoyne's instrument for measuring the diameter of the stars with great exactness; which instrument was afterwards shewed to the society, with the models of some others.—Mr. Hooke mentioned, that he had invented an instrument of this kind, but upon another principle which would perform the same things better, with more certainty and more ease.

July 12, 1682. A proposal was read of Mr. John Collins for the printing a book of algebra [Thomas Baker's "The Geometrical Key"]. This was well approved of after a long debate concerning it.

Societies and Academies.

LONDON.

Royal Society, June 26.—J W. **Nicholson**: The electrification of two parallel circular discs. The paper deals with the general application of spheroidal harmonics to the problem of two bodies not belonging to the same confocal system. The special case of two circular discs is reduced to a mathematical necessity for the determination of an infinite set of coefficients in a series involving Bessel Functions of half-integral order. This in turn is reduced to an integral equation of a new type, the kernel of which is

$$K(x, y) = \frac{\sin a(x+y)}{x+y} + \frac{\sin b(x-y)}{x-y}.$$

The equation is solved exactly, and exact expressions are found for the capacity of the double-disc condenser, and for the coefficients of capacity and induction of two discs with any charges.—J. F. **Fulton**: The influence of initial tension upon the magnitude and duration of the mechanical response in skeletal muscle. When the unexcised gastrocnemius, sartorius or semitendinosis muscle of the frog is stimulated through its cut nerve under various degrees of initial passive stretch by 50 break shocks delivered at 70 per second, so long as the circulation in the muscle remains vigorous, the following features are to be observed in the successive responses: The greater the initial tension within physiological limits, (*a*) the greater is the plateau tension of the resulting tetanus; (*b*) the longer the time of ascent to the plateau; (*c*) the greater the duration of the plateau *after* cessation of the stimuli ("after-action"). It seems that the general shape of the tetanus curve is determined by the rate of migration of the H-ions of lactic acid, and that the after-action represents the time spent by the ions in migrating from the place of their origin to the contractile interfaces upon which they act. The enhanced duration of the after-action with increasing tension is believed to result from the effect of the increased internal viscosity of the muscle upon the migration rate of the ions.—J. R. H. **Coutts**, E. M. **Crowther**, B. A. **Keen**, and S. **Odén**: An automatic and continuous recording balance. (The Odén-Keen Balance.) An improved form of automatic and continuous recording balance has been devised by combining electromagnetic control with the addition of small weights. A magnet suspended from one arm is attracted by a solenoid-current which is adjusted to maintain equipoise by the automatic movement of a contact along slide wires. The position of this contact is sufficient to define the effective weight, and is recorded on a rotating drum. On reaching a fixed point the contact is brought back to its original position by the addition of a small phosphor-bronze ball to the balance pan, and the cycle of operations recommences. The records consist of a series of stepped curves and a very open scale is obtained so that the apparatus can be used with no appreciable loss of sensitivity up to the maximum load for an analytical balance. Further, the sensitivity can be very simply adjusted for recording either rapid or slow changes of weight.—R. W. **Lunt**: Chemical studies in gaseous ionisation. Pt. I.: This communication constitutes the introduction to a series. Ionisation in hydrogen is produced by the corona due to alternating electric fields of frequency $1 \cdot 5 \times 10^7$. A new analysis of the Siemens ozoniser is advanced which affords a ready determination of the voltage gradient in the gas, and of the current carried by the ions in the gas. The mean intensity of ionisation is calculated from an equation relating the conduction

current in the gas to the known motions of ions and electrons in hydrogen Pt. II.: The interaction between hydrogen and carbon dioxide due to the ionisation produced by alternating electric fields of frequency $1\cdot5 \times 10^7$ has been examined under a variety of conditions An equimolecular mixture interacts giving a water gas equilibrium, which is also attained by exposing mixtures of carbon monoxide and water vapour to the discharge. In no case has it been possible to detect the formation of formic acid or formaldehyde. The equation used in Pt. I. for the determination of the mean intensity of ionisation in hydrogen has been extended to the determination of this quantity in the above-mentioned water-gas equilibria.—D. W. **Dye**: A self-contained standard harmonic wavemeter. The wavemeter provides a series of harmonics as a result of exactly timed electrical impulses which operate on a highly selective oscillatory circuit. The impulses are provided by either of two multivibrators. One of these has an impulse frequency of 1000 cycles per second, and is controlled in frequency by a valve-maintained tuning fork. The other multivibrator has normally a fundamental frequency of 20,000 cycles per second, and is controlled by the help of the 20th harmonic of the low-frequency multivibrator. The selector circuit consists of a specially designed variable air condenser and a set of six inductance coils of small damping decrement. The six scales are direct reading in frequency, uniform, and cover the range 10 to 1200 kilocycles. Owing to the master control of the tuning fork over both multivibrators, all the frequencies available are accurate to at least one part in ten thousand, and are not dependent upon the calibration, setting, or constancy of any electrical circuit. Intermediary subsidiary harmonics are readily obtainable from the apparatus; by the aid of these, the gaps between the main harmonics can be reduced to about 2 per cent. in frequency in the worst case.—W. L. **Bragg**: The influence of atomic arrangement on refractive index. It is assumed that the atoms, which are polarised by the electric force associated with the light wave, are spherically symmetrical ions, that the elastic yield of the ion to the polarising force is defined by a coefficient λ, which is a constant for the ion concerned, and that the polarising force may be taken to be that at the atomic centre The birefringence of calcite and aragonite, using the X-ray determinations of crystal structures, has already been explained quantitatively. That of aluminium oxide is now explained. An attempt is made to attack the reverse problem of using the refractivity data to give information about crystal or molecular structure. A comparison of refractivity in carbonates and nitrates indicates a contraction of the NO_3 group as compared with the CO_3 group, and a value for the distance between nitrogen and oxygen atomic centres is obtained.—A. V. **Hill** and H. S. **Gasser**: The dynamics of muscular contraction. In a muscular contraction carried out with various speeds of shortening, the work done is a function of the speed, decreasing as the latter increases. This was previously attributed to the viscosity of the muscle substance. It might depend, however, upon some kind of nervous adjustment carried out through a proprioceptive reflex. The experiments were repeated on an isolated muscle stimulated directly; the same dependence of work on speed of shortening occurred. This is a characteristic, therefore, of the muscle fibre. If the work decreases with increase of speed, so also must the force of contraction, and one striking result obtained is that a quick release of a muscle through 10 to 15 per cent. of its length causes an instantaneous disappearance of tension, which then redevelops along a curve similar to the initial curve of tension development. The viscosity of a muscle increases some fifteen times while the muscle is being stimulated, and it is possible on a viscous elastic model to repeat the phenomena. The fundamental mechanical response of muscle is probably a sudden instantaneous reversible colloidal change which passes off rapidly, the external mechanical response following the internal change, but lagging behind it owing to viscosity.—G. S. **Currey**: The colouring matter of the blue pansy. The anthocyanin pigment of the blue pansy "Emperor William" consists of violanin, and the blue colour of the petals is due to the fact that the pigment is present in the form of its potassium salt; it occurs to the extent of ca. $6\cdot3$ per cent. by weight of the dried petals ($=1\cdot14$ per cent. of the fresh petals). The yellow sap-pigment consists of the flavonol, rutin (viola-rutin). As crude glucoside, it is present to the extent of ca. $9\cdot68$ per cent. by weight of the dried petals ($=1\cdot75$ per cent. of the fresh petals), the actual amount of pure rutin being $50\cdot4$ per cent. by weight of the crude substance, *i.e.* the dried petals contain approximately $4\cdot9$ per cent. of pure rutin ($=0\cdot88$ per cent of the fresh petals).—R. **Snow**: Conduction of excitation in stem and leaf of *Mimosa pudica*.—R. **Azuma**: Thermodynamic phenomena exhibited in a shortening or lengthening muscle. When an excited muscle is released—whether doing external work or not—during the earlier phase of tension development, the heat production is increased; when released at a later phase the heat production is diminished. When an excited muscle is stretched, the converse result is obtained. This suggests that the effects are reversible and thermodynamic in origin, superimposed upon the ordinary irreversible reactions of muscular activity. These conclusions confirm and extend recent observations by Fenn—H. **Taylor**: The ionic nature of hæmoglobin. By laking the corpuscles by freezing and thawing and suspending in them a collodion membrane which contains a dilute salt solution and is impermeable to hæmoglobin, a Donnan equilibrium is obtained after about three hours The membrane potential difference is measured and this gives the factor relating the ionic concentrations of the laked corpuscles and those of the crystalloid solution inside the collodion membrane. From this potential difference and an analysis of the crystalloid dialysate, the concentrations of the hydrogen and chlorine ions in the laked corpuscles have been determined. The potential differences found indicate that the hæmoglobin is behaving as an anion over the range of physiological importance. The normality of the hæmoglobin ions present indicates the maximum amounts of carbon dioxide the blood can further take up as bicarbonate.—J. **Stephenson**: On the blood-glands of earth-worms of the genus Pheretima. The blood-glands of three species of Pheretima consist of numerous small spherical follicles within the hinder part of the pharyngeal mass, and on the dorsal side of the œsophagus. A fully developed follicle consists of a fibrous capsule, a cup-shaped layer of nucleated protoplasm, a loose mass of cells within the cup, and a blood-sinus on the convexity of the cup, between this and the capsule. A blood-vessel leads off from the sinus, and another from the opposite pole of the follicle. The follicle is the seat of manufacture of blood-cells and hæmoglobin. The vascular system in annelids and in the groups derived from annelids, and possibly in other groups also, has a double origin; its peripheral portion has been evolved independently of its more central and contractile portion. The analogies between the development of the vascular system in Oligochætes and Vertebrates are convergences, and imply no genetic relationship between the two phyla.—H. Muir **Evans**: Supplementary note on the poison gland of Trygon.—E. M. **Crowther** and

A. N. Puri: The indirect measurement of the aqueous vapour pressure of capillary systems by the freezing-point depression of benzene. The freezing-point of benzene is depressed by an amount which is strictly proportional to the aqueous vapour pressure of an insoluble material with which it is in equilibrium, provided that surface energy is not one of the factors determining the vapour pressure of this material. The method is rapid and accurate when applied to substances such as sulphuric acid-water mixtures and certain salt hydrates. With capillary systems such as soil, the equilibrium is reached more slowly and the apparent vapour pressures show a systematic deviation which is the same for soils of widely different types. By assuming that a fraction of the water in such cases is held in micropores and making allowance for the effects of the changes in surface energy on the introduction of an additional liquid phase, it is possible to account for this deviation.—B. Cavanagh: Activity-measurement by the partition method. I. A new way of applying the partition-ratio is suggested as an indirect means of precise activity-measurement. Precise measurements are made of a partition-ratio at extremely low concentrations, and preliminary measurements, in the case of lithium chloride between amyl alcohol and water, are recorded, in which the normality, N/8000 (in the alcoholic phase), has been reached. The method consists essentially in the piecemeal preparation of a large amount of the phase to be analysed, and the concentration (for chemical estimation) of the solute therefrom, by a process of piecemeal extraction. The method depends on the possibility of calculating exactly, and applying by successive approximations, a correction for the amount of the solute evading extraction. Approximate values have been obtained, for the first time, for the activity coefficient of lithium chloride in amyl alcohol, at normalities ranging from 0·2 to 0·0001.—J. E. Jones: On the determination of molecular fields. Pt. I. By applying the methods of the kinetic theory to a new molecular model, a new theoretical formula for the coefficient of viscosity of a gas has been obtained. In the case of argon, the difference between theoretical and experimental values is nowhere greater than 0·6 per cent. over the whole range of the observations (−180° to 180° C.). Pt. II. The equation of state of a gas has been calculated for a molecular model consisting of repulsive and attractive fields, each according to an inverse power law. The formula for the *second virial coefficient* thus obtained contains existing formulæ (for a monatomic gas) as special cases. The force constants of a gas are obtained from a comparison of the theoretical formula with observational material on the equation of state. In the case of argon, more than one molecular model will explain the facts.—C. J. Smith: An experimental study of the viscous properties of water-vapour. The viscosity of superheated water-vapour over the range of temperature 100°-260° C. has been determined. The method involves the transpiration of the superheated vapour through a capillary tube, determining the pressure at its ends and the mass of the vapour transpired. The variation of the viscosity with temperature can be represented by Sutherland's formula. The dimensions of the water molecule obtained are in accordance with previous investigations for other gaseous hydrides.—E. M. Crowther and J. R. H. Coutts: Discontinuity in the dehydration of certain salt hydrates. The changes in weight on rapidly drying certain salt hydrates have been recorded continuously by means of the Odén-Keen automatic recording balance. With thin layers of small crystals of copper sulphate pentahydrate and barium chloride dihydrate, the rate of evaporation shows a very marked minimum value at points corresponding to the composition of definite lower hydrates. An explanation of the observations is advanced on the basis of Langmuir's theory that heterogeneous reactions proceed only at the actual phase boundary. No evidence of discontinuities was found in the rehydration of anhydrous copper sulphate.—W. R. Dean: The elastic stability of an annular plate. A plane circular annular plate is under uniform shearing forces applied at its edges, and the problem is treated by the methods of the theory of thin shells. Plates with clamped edges in which the ratio of outer to inner radius exceeds 3·2 are discussed. With the analysis given, a certain type of uniform tensional stress can be allowed for in addition to the uniform shear.—R. C. Johnson and W. H. B. Cameron: The effect of argon on certain spectra. Investigations have been made of the effect of argon on spectra associated with carbon, oxygen, and sulphur; while in certain respects the action of argon and helium is similar, there are also profound differences. It has not been found possible to reproduce the "comet-tail" bands in high pressure argon, but the "triplet system" of carbon is isolated by both the inert gases. An effect of a similar type due to argon has been observed in connexion with sulphur dioxide. A band spectrum of the latter (obtained otherwise only with difficulty) was brought up strongly in the presence of high pressure argon.—G. R. Goldsbrough: On the possible ellipticity of Saturn's ring. Maxwell showed that a single circular ring of particles surrounding the planet Saturn would be in relative equilibrium, provided the mass of each particle was sufficiently small compared with the mass of Saturn. This result is extended to the case of an elliptical ring. By properly placing the particles on the ellipse, by allowing the ellipse to rotate slowly in its plane, and the particles to vibrate about their mean positions, then the elliptical ring is a possible dynamical form. For sufficiently small values of the mass of the particles, and for values of the eccentricity not too great, the elliptical ring will be "ordinarily" stable.—E. C. Titchmarsh: The double Fourier series of a discontinuous function. The object is to discuss the behaviour of the double Fourier series which represents a function of two variables, at a point where the function is discontinuous. Such a double series is not necessarily convergent in the general sense; but if it is summed in special ways, *e.g.* by rows or by columns, different sums may be obtained, depending on the values of the function in particular regions surrounding the point considered.

Geological Society, June 4.—Dr. J. W. Evans, president, in the chair.—H. H. Swinnerton: On a new catopterid fish from the Keuper of Nottingham. Excavations made at Woodthorpe, near Nottingham, passed through the lowest beds of the Keuper Water-stones, and brought to light numerous well-preserved remains of fossil fishes belonging chiefly to the genus Semionotus, together with specimens of a small fish which proved to be a new species of the genus Dictyopyge. This fish is only 4·5 cm. long, and slightly more than 1 cm. deep. In osteological characters it resembles the Eugnathidæ rather than the Palæoniscidæ. The pectoral girdle, however, has an infraclavicle, a feature which is diagnostic of the Catopteridæ. The detailed study of this new species confirms the usually accepted opinion that the Catopteridæ, although classed with the Chondrostei, approach the Protospondyli.—C. E. Tilley: A preliminary survey of metamorphic zones in the Southern Highlands of Scotland. A preliminary metamorphic survey of the Dalradian sediments enclosed within a tract extending from Dunkeld in Perthshire to the western side of Lower Loch Fyne (Argyllshire), and reaching from the Highland Border to the Ben Lui Schists that structurally overlie the Loch Tay Lime-

stone (16 miles across the strike), has been made. The important lines of dislocation, such as the Loch Tay Fault, the Luib Fault, the Tyndrum Fault, etc., displace not only the stratigraphical horizons, but also the metamorphic zones, and in the same direction. Where the boundaries of the zones cross areas of marked topographic relief, information should be provided by the trace of the zone surface. The Braes of Balquhidder, near Loch Earn, are thus favourably situated, and examination shows that the boundary-surface (isograd surface) of the almandine zone is there inclined at low angles to the north-west.

Optical Society, June 12.—Col. L. E. W. **van Albada**: Wide-angle ortho-stereoscopy: its optical, practical, and psychological advantages. In the methods used, the objects appear to the observer in their natural sizes and correct spatial relation to each other. These methods are based on the theories of Wheatstone and Helmholtz. The introduction of exaggerated perspective or other unnatural effects is avoided when the stereoscopic photographs are viewed through lenses which have nearly the same focal lengths as those by means of which the pictures were taken, and provided that the stereoscopic lenses are free from distortion. A new type of wide-angle finder made to the author's design gives a clear image over about 85°, with perfect definition up to the edge of the field. —R. J. **Trump**: Binocular vision and the stereoscopic sense. In the appreciation of distance, neither the convergence of the eyes, the visual focus, nor the variation of these accommodations as the eyes sweep over the field, plays any vital part. The recognition of a familiar type of perspective system is important, even to the extent of over-riding the evidence of binocular parallax, when the two come into conflict. This may be shown by reversing the mounting of stereoscopic photographs, or by preparing stereo diagrams in which the perspective is not in accord with the parallactic displacements. Parallax is uncertain, or even breaks down, when not assisted by perspective. There therefore appears to be no "mechanism" of stereoscopic vision dependent upon binocular parallax, but the perception of distance is a psychological function, involving the interpretation of all the details in the images in the two eyes, in the light of previous association and experience.—T. **Smith**: A general solution of the first order aberrational equations. The general equation by which the properties of the component parts of a compound optical system are determined is put into a new form. Solutions are obtained consisting of terms containing arbitrary constants together with any particular solution. The particular solution itself is the sum of two parts, one of which is independent of the corrections required in the complete instrument, while the other contains only the terms which express these special conditions.

CAMBRIDGE.

Philosophical Society, May 19.—Mr. C. T. Heycock, president, in the chair.—C. D. **Ellis**: The high energy groups of the magnetic radium-*C* β-ray spectrum. The magnetic β-ray spectrum of radium-*C* has been remeasured and the absolute energies of the lines found to an accuracy of 1 in 300. Some of the γ-rays giving these lines have energies so great as two million volts, but yet no evidence is found of any abnormal conversion, all the prominent lines being due to conversion in the *K*, *L*, *M*. electronic levels. This renders it possible to find the wave-lengths of the γ-rays. The results bring out the importance of considering the origin of the γ-rays.—R. H. **Fowler**: The statistical theory of dissociation and ionisation by collision, with applications to the capture and loss of electrons by α-particles. The statistics of general two- and three-body processes of interaction by collision are surveyed. In order to preserve standard equilibrium conditions, a definite relation must be satisfied between the number of two-body collisions which lead to any particular type of dissociation (or ionisation), and the number of three-body collisions which lead to recombination by a process which is the exact replica of the process of dissociation with a reversed time scale. This relation is used to study the laws of capture and loss of electrons by α-particles through the interaction of the field of an atomic core. The complete theory predicts Rutherford's V^5-law for the ratio of double-charged to single-charged α-particles, and gives the correct numerical value of this ratio if we may assume, as is reasonable, that the density of lightly bound electrons inside an atom is of the order 10^{24} per c.c.—D. R. **Hartree**: The spectra of some lithium-like and sodium-like atoms. By means of some theoretical relations between spectra of different atoms ionised to such an extent that their electron structures are the same, the position of lines of the spectra of some lithium-like and sodium-like atoms is estimated. In several cases these calculated lines can be correlated with lines observed by Millikan in the hot spark spectra of the corresponding elements. Lines of the spectra Be II, B III, C IV, and possibly N V and O VI, of lithium-like atoms, and of the spectra P V and S VI of sodium-like atoms, are so identified.—H. W. B. **Skinner**: The relative absorbing powers of the *L*-levels for radiation of varying wave-length. The experiment consisted in photographing the fluorescent *L* spectrum of an element using X-rays of varying wave-length to excite it. A change in the relative intensity of a pair of lines shows that the relative absorbing powers of the L_{I} and L_{III} levels depend on the wave-length of the absorbed radiation. This confirms a result recently obtained in a different way by H. Robinson. Hence the well-known λ^3 law of absorption of X-rays does not apply to an *individual* *L* level.—H. **Hartridge**: Are the overtones of musical sounds always harmonic? There are at the moment two rival theories: one holds that the voice overtones are harmonic, the other that they are not. Evidence available at the moment appears to be in favour of the latter view, not only for the human voice but also for most musical instruments when performing normally.—H. **Hartridge** and F. J W. **Roughton**: Further developments in the technique for the measurement of the velocity of very rapid chemical reactions. Two different improvements have been effected. (*a*) to make the apparatus available for the investigation of chemical reaction of greater velocity; (*b*) to employ other methods, beside optical ones, for the determination of the stages arrived at by the reaction at different instants of time from its commencement. With regard to the former, it is now possible to make accurate measurements of mono- and bi-molecular reactions half completed in one-thousandth of a second. With regard to the latter, temperature changes in a moving fluid brought about by a chemical reaction can be ascertained by means of thermo-couples.—E. G. **Dymond**: On the measurement of critical potentials of gases. A method of measuring excitation and ionisation potentials is described in which the current-voltage curves are automatically differentiated. This increases the sharpness of the bends in the curves, and results in increased sensitiveness of measurement.—G. F. C. **Searle**: (1) An optical interference method of measuring Young's modulus for rods. A vertical steel rod is deflected by a load suspended from a horizontal arm attached to its upper end. Two horizontal metal plates are soldered to the steel rod and the lower plate carries a lens, the upper surface of which is

convex. The upper plate carries three adjusting screws against which a horizontal plane glass plate is held by springs. An opening in the upper plate allows the observer to view the Newton's rings formed between the lens and the glass plate when suitable illumination by sodium light is provided. The load and the lens are on opposite sides of the rod, and thus as the load is increased and the rod is bent by the bending moment, the distance between lens and plate is increased and the Newton's rings contract. For each ring that disappears at the centre, the distance between lens and plate increases by $\frac{1}{2}\lambda$, where λ is the wave-length employed. (2) A recording gyroscope. A vertical shaft carries a block to which is attached a horizontal axis. The axle of a cycle wheel is carried by a frame turning about this axis. When the wheel is spun and the proper precessional angular velocity is given to the vertical shaft, the plane of the wheel remains vertical. The upper part of the vertical shaft carries a smoked drum on which the record is made by two styles each operated by an electro-magnet. From the record taken can be found (1) the time of one complete revolution in precession, and (2) the number of revolutions of W about its own axis during that time.—D. H. **Black**: Some electrical properties of liquid sulphur. Films of distilled sulphur were obtained between two cones and the conductivity measured at various temperatures up to 200° C. It was found that the conductivity varied in a similar manner to the viscosity. The conductivity of liquid sulphur seems to be electrolytic in character.—T. M. **Cherry**: (1) The integrals of differential equations. (2) Poincaré's theorem on the non-existence of uniform integrals of dynamical equations.—H. W. **Richmond** and F. **Bath**: Loci having two systems of generating spaces.—R. **Hargreaves**: The quadratic form for radial acceleration, in the theory of relativity.—G. S. **Carter**: On the early development of the echinoderm egg. I—III. —D. **Keilin**: On the appearance of gas in the trachea of insects.—G. S. **Adair**: A comparison of the molecular weights of the proteins.—Miss I. A. **Hoggan**: The parasitism of *Plowrightia ribesia*.—R. C. **Woodward**: The overwintering of apple mildew *Podosphaera leucotricha*, in England.—K. G. **Emeleus**: The number of β-particles from radium-E. Using an electrical counter of the type devised by Geiger, the number of α- and β-particles from a source of radium-D, radium-E, and radium-F in equilibrium has been measured. After correction for reflection of β-particles at the source, their numbers were about equal. The β-rays from radium-D would not be recorded under the conditions of these experiments. On this assumption, the observed β-radiation was due to disintegration of radium-E, and since this was in equilibrium with the radium-F, it follows that about one β-particle is emitted per disintegrating atom of radium-E.

Official Publications Received.

Ministry of Public Works, Egypt: Physical Department. 1: Observations of Duration of Sunshine in Egypt and the Errors of an old Type of Recorder; 2: Anomalous Behaviour of the Silk Suspension of a Kew Magnetometer. By H. Knox-Shaw. 3: Corrections to Survey Department Paper No. 33—The Magnetic Survey of Egypt and the Sudan. (Physical Department Paper No. 15.) Pp. 15. (Cairo: Government Publications Office.) P.T.5.

Manchester Test of the Yadil Treatment of Tuberculosis in One Hundred Cases. Preliminary Report. By Alex. Clements. Pp. 28. (London: Quality Press, Ltd.)

Catalogue of India and Burma Forestry and Timber Exhibits in the India and Burma Pavilions; also in the H.M. Govt. Building, Lloyds Bank, Palace of Engineering, etc., British Empire Exhibition, Wembley, 1924. Pp. 139. (London: W. W. Howard Bros. and Co.)

Philosophical Transactions of the Royal Society of London. Series A, Vol. 224. A.620: The Principal Constituent of the Tides of the North Sea. By J. Proudman and A. T. Doodson. Pp. 185-219. (London: Harrison and Sons, Ltd.)

Leeds University. Nineteenth Report, 1922-23. Pp. 180. (Leeds.)

Koninklijk Magnetisch en Meteorologisch Observatorium te Batavia. Jaarverslag, 1923. Pp. 28. (Weltevreden: Landsdrukkerij.)

Museums of the Brooklyn Institute of Arts and Sciences. Report upon the Condition and Progress of the Museums, for the Year ending December 31, 1923. By William Henry Fox. Pp 60+3 plates. (Brooklyn, N.Y.)

Ninety-ninth Annual Report of the Committee of the Bath Royal Literary and Scientific Institution for the Year 1923. Pp. 12. (Bath.)

The Physical Society of London Proceedings. Vol. 36, Part 4, June 15. Pp. 241-340. (London: Fleetway Press, Ltd.) 6s. net.

Publications of the Kapteyn Astronomical Laboratory at Groningen. No 32. On a Thermo-electric Method of measuring Photographic Magnitudes. By J. Schilt. Pp. ii+31. No. 35: The Proper Motions of the Hyades derived from Plates taken at the Helsingfors Observatory, by Prof. A. Donner. Measured and discussed by Prof. Dr. J Van Rhijn and W. J. Klein Wassink. Pp. ii+19. (Groningen: Hoitsema Bros.)

Royal College of Surgeons of England. Annual Report on the Museum, by the Conservator. Pp. 24. (London: Royal College of Surgeons.)

Proceedings of the Cambridge Philosophical Society. Vol. 22, Part 2. Pp. 83-199. (Cambridge: At the University Press.) 5s. net.

Commonwealth of Australia: Institute of Science and Industry. Second Annual Report of the Director for the Period from the 1st July 1922 to the 31st December 1923. Pp. 70. (Melbourne: Albert J Mullett.)

Department of Agriculture, Ceylon Bulletin No. 55: Improvement of Yield in Hevea by the selection of Seed Bearers. By G. Bryce and C. H. Gadd. Pp 42. Bulletin No. 68: Yield and Growth in Hevea Brasiliensis By G. Bryce and C. H. Gadd. Pp. 74. (Peradeniya). 15 cents each.

Report of the Proceedings of the Fifth Entomological Meeting, held at Pusa on the 5th to 10th February 1923. Edited by T. Bainbridge Fletcher. Pp. xiii+422+38 plates. (Calcutta: Government Printing Office.) 9 8 rupees.

Government of Madras. Annual Report of the Chemical Examiner, 1923. Pp 13. (Madras.)

University of Illinois Engineering Experiment Station Bulletin No. 142: An Investigation of the Fatigue of Metals, Series of 1923. A Report of the Investigation conducted by the Engineering Experiment Station, University of Illinois, in Co-operation with the National Research Council, the Engineering Foundation, the General Electric Company, the Allis-Chambers Manufacturing Company, the Copper and Brass Research Association, the Western Electric Company. By Prof H. F. Moore and Prof. T. M. Jasper. Pp. 88. (Urbana, Ill.: University of Illinois.) 45 cents.

U.S. Department of Agriculture. Farmers' Bulletin No. 1407: The Mexican Bean Beetle in the East. By Neale F. Howard. Pp. 14. Farmers' Bulletin No. 1408: The House Fly and How to Suppress It. By L. O. Howard. Pp 18. (Washington: Government Printing Office) 5 cents each.

Proceedings of the Royal Society of Edinburgh: Session 1923-1924. Vol 44, Part 2, No. 12: A Static Model for Helium By Dr. H. Stanley Allen. Pp. 116-128. 1s. Vol. 44, Part 2, No. 13: The Cathode Fall of Potential in a High Voltage Discharge. By G. P. Thomson. Pp. 129-139. 1s. Vol. 44, Part 2, No. 14: The Electrolysis of Mixtures of Acetates and Trichloracetates. By Ralph Edward Gibson. Pp. 140-152 1s. 3d. (Edinburgh: R Grant and Son; London: Williams and Norgate.)

Bulletin of the National Research Council. Vol. 8, Part 4, No. 46: The Geological Implications of the Doctrine of Isostasy. By Andrew C. Lawson. Pp. 22. (Washington, D.C.: National Academy of Sciences.) 40 cents.

Department of Commerce: Bureau of Standards. Miscellaneous Publication No. 57: Large Mollier Chart (Foot-Pound-Fahrenheit Units) Properties of Ammonia 48 in.×20 in. (Washington: Government Printing Office.) 10 cents.

Proceedings of the Society for Psychical Research. Part 93, Vol. 35, June. Pp. 235 (London: Francis Edwards.) 16s. net.

City and County of Kingston upon Hull: The Third Port of the United Kingdom. (British Empire Exhibition, Wembley, 1924: Hull Civic Fortnight, July 2nd to July 15th.) By T. Sheppard. Pp. 40+8 plates. (Hull: Municipal Museums.)

Jahrbucher der Zentralanstalt fur Meteorologie und Geodynamik Amtliche Veroffentlichung. Jahrgang 1919 Neue Folge, Band 56: Pp. xvi+A36+B35+C72. (Wien: Gerold und Komp.)

Diary of Societies.

TUESDAY, JULY 15.

INSTITUTE OF CHEMISTRY STUDENTS' ASSOCIATION (London) (at University College), at 9 45 A.M.—Inaugural Meeting.

ROYAL SOCIETY OF MEDICINE, at 5.—General Meeting.

WEDNESDAY, JULY 16.

INSTITUTION OF CHEMICAL ENGINEERS (Annual Corporate Meeting) (at Hotel Cecil), at 11 A.M.—Sir Arthur Duckham: Presidential Address. —Sir F. Nathan: The Work of the Educational Committee on The Training of a Chemical Engineer.—E. A. Alliott: Self-balancing Centrifugals.—G. W. Himus and Prof J. W. Hinchley: Evaporation in Currents of Air.

FRIDAY, JULY 18.

ROYAL METEOROLOGICAL SOCIETY (Summer Meeting at the Rothamsted Experimental Station, Harpenden), at 2.15.—R. A. Fisher: Adaptation of Variety to Climate.—W. B. Haines: A Comparison of Three Different Types of Radiation Recorders.—Dr B. A. Keen: A Study of Ground Water Level Changes in Soil Cylinders.

SATURDAY, JULY 19.

PHYSICAL SOCIETY OF LONDON (Special Meeting at Cambridge), at 4.15.—Sir J. J. Thomson: Radiations in a Discharge Tube.—Sir Ernest Rutherford and Dr. J. Chadwick: Recent Experiments on the Artificial Disintegration of the Elements.—Dr. G. F. C. Searle: A Two-dimensional Recording Accelerometer for Aeroplane Research.

SATURDAY, JULY 19, 1924.

CONTENTS.

Editorial and Publishing Offices :
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.

Editorial communications should be addressed to the Editor.
Advertisements and business letters to the Publishers.

Telephone Number: GERRARD 8830.
Telegraphic Address: PHUSIS, WESTRAND, LONDON.

Lord Kelvin.[1]

THE hundredth anniversary of the birth of William Thomson, Baron Kelvin of Largs, was commemorated in Glasgow and elsewhere on June 25. Although Glasgow was the scene of Lord Kelvin's life-work, he was actually born in Belfast, where his father, James Thomson, was professor of mathematics at the Royal Academical Institution. The city of Belfast is, indeed, very proud of its association with the illustrious physicist, and an impressive statue of Lord Kelvin adorns its Botanic Garden, adjoining the Queen's University.

William Thomson was eight years of age when his father became professor of mathematics at the University of Glasgow, and the family exchanged Belfast Lough for the Clyde. Letters are still preserved which show Thomson's love of navigation and its problems, and how he tackled some of them in his youth with the help of his brother James, afterwards professor of engineering in the University of Glasgow. He was always a sailor at heart, and his name is one of the very few names of physicists which are familiar to mariners throughout the world.

Lord Kelvin's connexion with the University of Glasgow, which began in 1832 and was only severed by his death on December 17, 1907, witnessed an extraordinary series of changes in the status of science in the world's universities. In Glasgow, as elsewhere at the beginning of his career, "Natural Philosophy," as Dr. David Murray says, "was purely an Arts subject and was regarded as an instrument for what Francis Bacon terms 'that improvement of the understanding which results from the cultivation of natural knowledge, and that elevation of mind which flows from the contemplation of the order of the universe,' and was on the same footing as Logic and Moral Philosophy; it was not treated as part of a scheme for the training of specialists. This was certainly Professor Thomson's view, who held that Greek, as an instrument of culture and mental discipline, was an essential part of the Arts course and that every scientific man should have a fair acquaintance with it."

Lord Kelvin never went to school. All his education up to the age of ten was given him by his father, along with his brothers and sisters. He used to say that he never met a better teacher in *anything* than his father was in *everything*. At a dinner of the University of Glasgow Club in London, Lord Kelvin once said that the average boy should be able by the age of twelve to write his own language with accuracy and some elegance.

[1] "William Thomson, Lord Kelvin, 1824–1907: an Oration delivered in the University of Glasgow at the Commemoration on June 25, 1924, of the Centenary of Lord Kelvin's birth," by Dr. Alexander Russell. Pp. 22. (Glasgow: MacLehose, Jackson and Co., 1924.) n.p. "Lord Kelvin as Professor in the Old College of Glasgow," by Dr. David Murray. Pp. iv+22+4 plates. (Glasgow: MacLehose, Jackson and Co., 1924.) n.p.

He should have a reading knowledge of French and German, and be able to translate Latin and easy Greek authors. He should then study logic, in order to apply his words sensibly.

Lord Kelvin matriculated in the University of Glasgow at the age of ten, and at fifteen he gained a University medal for an essay on the figure of the earth. He entered Peterhouse, Cambridge, at the age of seventeen, and in 1845 was declared second wrangler and in the following year Smith's Prizeman. In this year, at the early age of twenty-two, he was elected to the chair of natural philosophy at the University of Glasgow. "Those," he said, "were the palmy days of Natural Philosophy—the pre-commissional days." They were the days when lectures were preceded by prayer, when the professor would "meet his classes" for two hours on five days of the week for six months, and would devote the rest of the time to original research, in which chosen students might take part as assistants. *Lehrfreiheit* was a reality then, and the professor might teach whatever seemed to him best for forming the character and stimulating the imagination of the students. There was no thought of training for manual dexterity, inventiveness, or practical research. "Science" had not yet arisen as a faculty to be cultivated for its own sake or placed on an equality with the *artes humaniores*. Had the commercial value and utilisation of science been an object of university training in 1846, William Thomson would, in all probability, not have accepted the chair. Yet he himself was a shining example of the economic value of scientific knowledge and invention based upon it. He made innumerable inventions, and from some of them he derived considerable wealth, which the poverty of his early days enabled him fully to appreciate.

The sixteen years from 1850, when a steam tug laid the first submarine cable between Dover and Calais, to 1866, when the first permanent cable was laid between Europe and the United States, showed Lord Kelvin in a new light. He formulated and expounded the theory of cable transmission, and when he became a director of the Atlantic Telegraph Company, he did the work of the "drummer boy" in steering the company through the crises produced by the repeated failures of the cables. "What has been done," he said to the shareholders, "will be done again." The 1865 attempt was a failure, 1800 miles of cable being left at the bottom of the sea. But in the summer of 1866 not only was a new cable laid, but the old one was also recovered and completed.

While his work on cables gave Lord Kelvin his knighthood and the freedom of the city of Glasgow, it gave the electrical world the mirror galvanometer and the siphon recorder. These were followed by the electrostatic voltmeter and the electrodynamic balance. Lord Kelvin was a convinced advocate of the metric system, and his strenuous partisanship stimulated his colleague, Prof. Macquorn Rankine, to write his ballad "The Three-Foot Rule," which begins:

Some talk of millimetres, and some of kilogrammes,
And some of decilitres, to measure beer and drams;
But I'm a British workman, too old to go to school;
So by pounds I'll eat, and by quarts I'll drink, and I'll
work by my three-foot rule.

Lord Kelvin's laboratory, or "experimental room," as it was called, was an entirely new departure, and was the earliest physical laboratory in Great Britain. His manner of lecturing has been much admired and much criticised. Some say he was always above the heads of his students, and that he could not conceive their being subject to error. Sometimes he would let a student work out a problem of mathematical physics in the class, and would himself write down what the student dictated. After he had covered the whole blackboard on one occasion, the bewildered student said, "I am afraid, sir, I do not see where I am going." "Neither do I, Mr. Gillies; you may sit down," and the professor then sponged out all the ridiculous operations he had written down. He would, however, not tolerate facetious or irreverent answers, and would reprimand them severely.

On another occasion he despatched two students to the top of the College tower to take some observation with an electrometer. They reported the result, but it was of the opposite sign to what Lord Kelvin had expected. The professor was nonplussed, and advanced all sorts of theories to account for the result, only to reject them all as inadequate. Next morning he said he had spent the night trying to arrive at some explanation, but had not succeeded. On the third morning he appeared radiant. "Gentlemen, I have it now; they turned the instrument upside down." "It was the last thing that occurred to him," says Dr. Murray, "that a student in the Natural Philosophy class in the University of Glasgow could do so stupid a thing."

Kelvin has often been likened to Helmholtz, and for some time, indeed, the two had similar eminence and standing in their respective countries. Kelvin's almost universal genius left a lasting impression on his age. His estimate of the age of the earth has been vastly extended by the discovery of radioactivity, and his bold conception of the vortex atom is no longer regarded as corresponding in any way to reality, but he was one of the mightiest physicists who ever lived—"the foremost Cambridge man of science since Isaac Newton, and the most distinguished of the professors of the University of Glasgow."

Instinct and Culture in Human and Animal Societies.

Le Monde social des fourmis, comparé à celui de l'homme. By Auguste Forel. 5 vols. Pp. xiv + 192; iii + 184; vii + 227; vii + 172; vi + 174. (Librairie Kundig, Genève, 1921–23.) 10 Swiss francs each vol. A Summary by the author: "Mensch und Ameise." Pp. 70. (Rikola Verlag, Wien, 1922.)

MAN is an animal, albeit a social animal, and unless the study of man be made to rest on the firm foundations of biology, this study is doomed never to become a real science. The truth of this has been keenly felt by the early sociologists. In fact it has been almost an obsession with them, and the analogy between society and organism, taken literally and applied as a unique principle of research, has misled and wrecked most of the earlier attempts at systematic sociology. For in science, as everywhere else, work done by proxy, by borrowing or copying, does not lead very far. Though sociology should never break its contact with biological science, it must achieve its results by its own efforts, and recognise that the entirely different nature of its subject requires specific methods, poses new problems, and opens up new aims. The relations between human individuals in society can be compared to the intercellular process within the living organism only in a mystic, semi-poetical simile and not in any scientifically useful analogy. As a method of sociological research and exposition this simile is worse than useless, as has been proved by the unfailing sterility of the many attempts at developing such social systems.

Yet the fallacy is so firmly established, so alluring, that even a sociologist and field worker so exact and critical as the late Dr. Rivers, attempted in his last book ("Psychology and Politics," Kegan Paul, 1923) to give it currency once again. We read there, on p. 62, that the resemblance between the living organism and society "is something more than an analogy, and depends on the operation of some fundamental laws of development common to both organism and society." Again, the leading British anatomist and anthropologist, Sir Arthur Keith, approaching the problem from the biological point of view, writes in a passage, which, I confess, gave me a genuine pang of dismay, "the resemblance between the body physiological and the body political is more than an analogy: it is a reality" (The Rationalist Press Association Annual, 1924, p. 11). I fail to see why a *reality* should disguise itself as a *resemblance* and be perceptible only through an *analogy*. In any case, it is not superfluous to question the opinion of two such eminent thinkers and to give a demonstration, as I shall presently attempt to do, that there exists no analogy whatever between society and organism, in any scientifically useful sense of the word.

There are sociologists again who, abandoning the hopeless confusion between intercellular process and social relations, yet try to transfer certain theories from the evolution of life to that of societies. They regard anthropology and sociology as a science of social evolution and adapt such concepts as "struggle for existence," "natural selection," "adjustment to environment," to explain all facts of society. Apart from the recent, in the main very pertinent, criticism of exclusive evolutionism in anthropology (Pater W. Schmidt in Austria, Dr. Graebner in Germany, Dr. Rivers, Prof. Elliot Smith, and Mr. Perry in Great Britain) there is no doubt that the laws and principles of organic evolution do not hold good with relation to human societies, where the facts of organisation and culture introduce a new element and change the whole aspect of the process.

Recently we have witnessed another intrusion from biology into social science in the assertive and stimulating theory of the so-called herd instinct, which is supposed to be at the bottom of all social force and to explain all human institutions, laws, beliefs, fashions, and customs. This view, very popular among the amateur psychologists and sociologists of the day, will not bear a close sociological examination.

The question therefore remains: In what way should the sociologist establish his contact with biological science? In what exchange of services can the two studies derive mutual benefit? Where, on the other hand, must they draw the line of demarcation and recognise that the difference of their respective subject-matters precludes borrowing or encroachment? The answer to these questions cannot be hit upon *a priori* by a happy simile, inspired phrase, or armchair formula. It must come from careful comparative study of animal and human societies.

When therefore a pioneer biologist, and a student at first hand of human nature in several of its departments, summarises his life work on the social relations of ants, and does it with his attention directed to the comparative problems of human and animal sociology, this is an event of unusual importance for those who want to understand the biological foundations of society. The perusal of these five volumes, beautifully written and magnificently produced, with numerous plates, figures, and illustrations, fulfils the most exacting expectations of those who have learnt to admire Prof. Auguste Forel as a great entomologist, first-rate student of the human mind, and daring social reformer. It would be superfluous to recommend the work to the attention of the zoologist or biologist, and

no psychologist or philosopher will fail to find a mine of inspiration and suggestion in it. But its value for comparative sociology might perhaps not be so obvious, and it is on this point that it will be well to enlarge here.

The sociologist who, after his preliminary introduction (in vols. 1 and 2) to the ants, their anatomy, physiology, mentality, classification and distribution, follows up the fascinating description of their social life, will be at once impressed by the breach of continuity between the human and insect societies. Whereas in human groups, collective behaviour is co-ordinated by certain social forces, resting on *organisation* and supported by a scaffolding of *culture*, there is among the ants a complete absence of these two elements. Instead of this we find co-ordination by *instinct* and by *anatomical and physiological arrangement.*

If we compare the sociability of the ants with that of man, we find, as I have said, that the insects achieve their unity of action by instinctive arrangements which prompt each individual ant to respond to a specific stimulus in the same manner. Take, for example, their constructive activities. Prof. Forel gives a description of their natural implements, the specific bodily organs adapted in different species to different building aims. He describes the architecture of their nests, which, measured by the stature of the builders, would in certain cases dwarf the Pyramids by their size and crush sky-scrapers by their mass. When we follow the little insects at work, we find that the division of labour is rooted in the natural fact of polymorphism; that their tools and their tasks are prescribed to them by their anatomical structure; that any social organisation in the sense of hierarchy or compulsion is absent; that every insect is put in its place and works at its task, following an inner instinctive urge. Compare this with a group of men at work. Whether it be a savage community building a house or a canoe, or engaged in a hunting or fishing expedition, or whether we consider modern working men employed in some large industrial enterprise, we have a different picture. The division of labour is not based on fundamental anatomical differences, and the implements are not given by Nature but supplied by culture. The individual workers are not moved by instinct, but by the forces of social organisation which allows a small number of leaders to compel or lead or persuade the rest to work at a task in itself unpleasant. The anatomical equipment and instinctive endowment are supplanted by the gifts of material culture and the forces of social organisation.

If we study the family life of an ant-heap, and compare it with human marriage, family, and kinship organisation, we come to a similar conclusion. The biological chapter in the story of propagation is much longer and more complicated with the ants than with humans. By a natural division of functions, only a small part of the insect community is anatomically fit to mate and to produce offspring. With them the romance and tragedy of the nuptial flight and annihilation of the males, so vividly and fully described by Prof. Forel, is much more sharply defined by instinct and provided with greater variety of incidents than is the case with man. The further history of the progeny is still more complicated and requires practically in every species of ants a co-operation of one or more polymorphic forms which act as nurses, defenders, carriers, and feeders of the brood. Yet, in each phase of this very complicated process, we see that everything happens merely by the promptings of instinct, in satisfaction of a physiological need or natural craving specifically adapted to the process.

In the simplest forms of the most primitive human society, similar ends are brought about by entirely different means. While the anatomical and physiological difference is limited to the division of sexes, we see that the instinctive promptings to mate and take care of the progeny are in every one of their most elementary manifestations moulded, complicated, and co-ordinated by forces of tradition, organisation, and culture, of which we can perceive not even traces in the insect society. From the moment of birth, nay, from that of conception, the new human organism in the womb is the object of traditional observances: taboos, magical or religious rites, in higher societies hygienic rules and customary observances. The nursing, tending, and education of the child in human societies is also largely defined and consistently moulded by the tradition of the tribe; by its economic conditions, its legal system, and its material culture. No doubt, both in sexual relations and in kinship bonds, the instinctive elements play a paramount rôle, yet in both they are invariably and powerfully modified by tradition. To this is due the fact that in no two savage tribes, in no two types of civilisation, do we find exactly the same sexual morals, marriage customs, or systems of kinship, while on the other hand we have to recognise that the underlying instincts and tendencies do not essentially differ throughout humanity.

M. Forel describes in detail the wars of ants, and with a certain zest of pessimism compares them with those of man. Here we see the same relation. As in love, so in hatred, the ants are moved by instinct and instinct alone. Every species, nay, every ant-heap, has its natural enemies—some stronger, some weaker, some belonging to the ant family, some to other animal domains. Against these the soldiers or workers will fight to death, using their natural anatomical weapons, moved one and all by the same hostile impulse, dropping naturally each into its place in the fighting-line.

How welcome would be such an army to one of those modern generals or politicians or journalists who seem to regard wholesale brutal destruction of life as the chief end of humanity! Yet human nature, bad as it is, and capable of unlimited depravation, is at least plastic, and it has to be fashioned into the negative evil, hostile attitude of hatred, even as it could be fashioned into an attitude of international tolerance, generosity, and desire for co-operation. Man has to manufacture the impulse of hatred, instinctively present in an ant-heap. In a savage tribe this is done by tradition, which, from generation to generation dictates to the tribesman who is his enemy and who is a friend. In our modern societies a shoddy mock-tradition of hatred is frequently manufactured in a week or so by the powerful, though despicable machinery of newspaper trusts, in which a leading mediocrity dictates to millions of others the basest and most negative feelings and impulses for destructive action. The weapons given by Nature to an ant-soldier, man had to create by means of civilisation —save the mark—and where in the insect army every soldier ant knows his place instinctively, man has to create his army organisation by ingeniously devised drill and subordination.

The chapters about the wars, predatory expeditions, and struggles of the insects in Prof. Forel's fourth and fifth volumes, read more excitingly than any imaginative novel or fantastic insect play. Some of the reflections of the author—notably in the small German booklet "Mensch und Ameise"—given with the vigour and enthusiasm of youth and with the wisdom and simplicity of age, afford admirable and inspiring reading.

We could similarly compare the economic activities of the ant-heap—their search for food, their "cattle," gardens, various arts and crafts—with those of man; or enlarge on the interesting problem of their means of mental communication and compare them with human language. The conclusion would be always the same. In human societies there exists a man-made system of material products, endowing the individual with the various implements, weapons, economic contrivances, each of which corresponds to some specific item in the anatomical equipment of the ants. Above all, there is the supreme human implement, language, which means thought and also community and continuity of thought. Language gives the possibility of tradition—that is, of the system of rules, ideals, moral precepts, laws, which mould, modify, and co-ordinate human instincts. In animal societies sociability is based directly on instinct: animals act in masses, for, having to live in masses, they are always moved by the same response to the same stimuli. Men act in groups because they are organised into societies—that is, their instincts have been shaped by tradition, a number of traditional motives has been inculcated into them, and they have been taught to use in co-operation the same apparatus of material culture, including language, the implement of thought. The animal, whether social or not, stands in immediate contact with the environment, its instincts being directly adapted to it. With man, culture stands between him and Nature as a secondary means of adaptation, and a secondary *milieu* at the same time.

This point of view will allow us to deal trenchantly with some of the fallacies enumerated at the outset: the society-organism simile, the herd instinct, and the wholesale borrowing by sociology of evolutional principles. Since the unity of the human group is brought about by the extremely complex process in which, through the co-operation of individuals and generations, tradition and culture and organisation are formed, sociology has to study this process, instead of comparing it to a thing so entirely different as a natural organic unity in which the cells of an organism are bound up. Again, since man, unlike the animal, does not stand in a direct immediate relation to environment, there is no use speaking about natural selection or struggle for existence, for these things do not apply to man, the only animal armoured by culture, tied with traditions, living in the artificial, secondary *milieu* of organised society.

Now, is there any specific herd instinct which would form the foundation of the sociability of an ant-heap? We have seen that life, in an insect community, follows several lines of typical, inherited behaviour, each associated with a special anatomical and physiological arrangement, each furnishing definite responses to specific features of the environment. Nutrition, propagation, search for food, various forms of aggression and defence, several types of symbiosis, all consist of a number of instincts each. But there is no special natural outfit, no physiological arrangement, not one single inherited tendency or response which would correspond to sheer sociality. Gregariousness is the general aspect of all their instincts, but certainly not one specific instinct. Prof. Forel does not show us anything or speak of anything even approaching herd instinct, nor can anything of the sort be detected by the most careful reader. If we have to discard this figment with reference to the most gregarious of animal societies, there can be still less room for it in the communities of man. "Human gregariousness" is even more removed from instinct than that of animals, and it consists essentially of the manner in which the various human instincts are moulded and co-ordinated by material culture and tradition, so as to result in the various mental uniformities which underlie organised behaviour.

We see, therefore, that even a brief summary of Prof. Forel's thorough and valuable results has enlightened us on the question of the biological foundations of society. We have seen that the distinctive features of human society are *organisation and culture*, the man-made, artificially created cohesion, and the man-made environment and equipment of the individual. Yet neither organisation nor culture is built up on the quicksand of human whim or creature imagination or contract or free will or historical accident or however we might call the "indeterminate mental." They are built on the foundations of instinct and in this the study of society stands in close relation to biology. But human instinct, unlike that of animals, is essentially plastic, and herein lies the possibility of culture. In studying how the plastic human instincts are modified in society, we learn to understand the nature of material culture, language, and tradition—the sum-total of civilisation. The further we push the study of the relation between instinct and culture, of the transformation of instinctive impulse into the social forces of beliefs, ideals, moral norms, and social sentiments, the better we learn to understand the enormous benefit derived by the sociologist from a comparative study of animal and human communities and the importance to him of a right understanding of the biological foundations of human character.

B. MALINOWSKI.

Oyster Mortality.

Ministry of Agriculture and Fisheries. Fishery Investigations. Series 2, Vol. 6, No. 3, 1923. An Account of Investigations into the Cause or Causes of the unusual Mortality among Oysters in English Oyster Beds during 1920 and 1921. Part I.: Report. By Dr. J. H. Orton (assisted in Laboratory Work by Miss Edith Worsnop. Pp. 199+12 plates. (London: H.M. Stationery Office, 1924.) 15*s*. net.

IN September 1920 there was a scare about the heavy mortality amongst the oysters on the layings of the Thames Estuary. This scare passed to Colchester, and to every part of the East Coast, and similar death-rates were also mentioned from the south and west. The matter was investigated by the Development Commission's Advisory Committee on Fishery Research, but so far as we can see from the Report before us, no accurate estimations were made of the deaths, either beforehand, or afterwards when it certainly would not have been too late; the Table given shows that unusual mortality was reported in the summer of 1921 in the Thames Estuary, and the only possible excuses for the lack of accurate investigation then are either that reports were not sent in at the time, or that the Development Commission refused to provide the funds for such. Oyster planters estimated the deaths in 1920 at 10 to 60 per cent. against an average of 10 to 15 per cent., but there is no indication upon what these estimates were based. As Holt in Ireland records losses from all causes of 39·6 and 54·6 per cent. on accurate figures, and Bulstrode showed that an English planter laid 241 millions in 13 years, and only picked up and sold 105 millions, we may be allowed to doubt the accuracy of the belief in this greatly increased and "abnormal" mortality, especially as no information is supplied as to deaths and the working of the layings in 1918 and 1919.

The Development Commission got to work with commendable rapidity. Drs. Orton, Brady, and Eyre, biologist, chemist, and bacteriologist, were engaged to investigate, and the first part of their Report is now published under Dr. Orton's name. The industry suggested poisoning by T.N.T. (tri-nitro-toluene), or some other poison, dumped into the sea, and the researches now described were mostly made to test this view. The examinations, analyses, and tank and other experiments were well conceived and done with the greatest care, but at the date on which the investigations commenced (Oct. 28) the mortality as indicated by hockley (hollow-sounding) oysters is stated to have been over. The work shows that it is "unreasonable" to suppose that the deaths can have been due to T.N.T. Various metals, nitrites, salts of picric acid and oil were considered one by one and eliminated. Indeed, the theory of poisoning would seem to have been almost definitely disproved, but we think that this disproof would have been stronger if there had been more investigation into the directions of the currents from the dumping areas, and if a systematic inquiry had been undertaken into the mortality of other animals, especially near the dumps, as laid down by the Advisory Committee on Fishery Research in their original resolution. Are there any records of heavy deaths among the slipper limpets or other molluscs, either on the oyster layings or elsewhere?

Coming to natural conditions, such as might be caused by fluctuations in weather, a comparison is made between 1912 and 1919 as two similar years, but no unusual mortality is recorded or recollected for 1912. The figures for layings and sales must surely be in the books of the chief oyster planters for the last twenty years, and would be interesting in this connexion; their publication could be of no harm from a trade point of view, as planters generally are sold out before the end of the season. The way the grounds are worked (cleaned up by dredging, harrowed, etc.) year by year would also require to be known, but the com-

plications introduced by that horrible American pest, the slipper limpet, would make figures of costs of little value. There were clearly large numbers of sea urchins and starfishes as well on the beds at Whitstable, but these are regarded as evidence of the healthy conditions of the beds, and the relative number of these most destructive animals in 1920 as compared with other years is not estimated; if 1919 was a year of poor shell growth, so far as thickness was concerned, either form might have caused a great rise in mortality in 1920. Dr. Orton especially asks for experiments as to temperature and salinity designed to cover yearly fluctuations.

The full results obtained by Dr. Eyre relating to oyster bacteria are deferred to Part II. of the Report, but interesting experiments with the filamentar Cladothrix are recorded. Weak oysters were found by Dr. Orton to have, as an almost constant symptom, peculiar muscle spindles, derived from the adductor muscle holding the shells together, individual spindles varying from 8μ to 90μ in length; they were also produced experimentally. This investigation and those on the crystalline style and on "bleeding" are largely new and will require to be read by every zoologist, to whom they will form the most valuable part of the researches.

The Report concludes by assigning no cause for the oyster mortality in 1920, the abnormality of which, as compared both with other years and the known conditions of certain of the grounds in 1919, the writer regards as unproven; in Part II. of the Report this matter should be considered. Some estimate of the months of greatest incidence of the mortality could easily have been made by the examination of the dead shells dredged up, and any correlation with the spawning season settled, this being a period of much death. We do not know enough about the food of oysters to make possible any consideration of the partial failure of their food supply at this season, this being in the writer's opinion the chief cause of death at Helford, provided that the layings are clean.

On the whole we consider that we are justified in calling this research a "panic study," and it would seem that it was really so as it was preceded by no accurate observations such as could have been made in three days off the Colne and at Whitstable. It was directly taken charge of by the Development Commissioners, and on the face of it the story as to T.N.T. and other poisons, comparing quantities dumped with the amount of water and its circulation, was a foolish scare. As an industrial matter it had to be undertaken in a special form, and certainly the excellent quality of the work put into it makes it scientifically valuable. All readers will be in agreement with Dr. Orton that we know far too little about the oyster, and that a good means of procuring knowledge would be that somebody "should found a Scholarship for Research on Oysters of a value of at least 300*l*. per annum" under suitable conditions, a suggestion that we would at once commend to the Development Commissioners.

J. STANLEY GARDINER.

Three-Dimensional Geometry.

Principles of Geometry. By Prof. H. F. Baker. Vol. 3: Solid Geometry, Quadrics, Cubic Curves in Space, Cubic Surfaces. Pp. xix+228. (Cambridge: At the University Press, 1923.) 15*s*. net.

IT is an undoubted fact that greater intellectual satisfaction is to be obtained from the proof of a geometrical theorem by the methods of pure geometry than from an algebraical investigation of the same theorem, and treatises on the methods of projective geometry are not uncommon, even in English. But apparently the application of such methods to the study of three-dimensional problems is considered difficult, for English text-books either confine themselves to plane geometry or else devote a chapter at the end to a meagre account of quadrics. As for investigating by this means the properties of a space cubic curve or a cubic surface, that is never dreamt of. Salmon's "Geometry of Three Dimensions" is, we believe, the only English book which gives at all a complete account of the cubic surface, and in Salmon, of course, the algebraical side preponderates. Prof. Baker's third volume fills, then, an undoubted gap. To get into 223 pages an account of quadrics, of the space cubic and of the cubic surface, has involved a great amount of compression which is perhaps to be regretted; the book makes difficult reading, but the matter is there, and whoever will take the trouble to study its pages with care will be amply rewarded.

The method of treatment follows on the lines laid down in the previous volumes, the second of which was noticed in our issue of September 22, 1923, p. 428, though naturally less emphasis is put upon the logical point of view and algebra is used more freely in illustration of and supplementary to the geometrical work.

The first two chapters, parallel to chaps. i. and ii. of vol. 2, deal with the quadric surface defined by means of its generators and with its relations to a fixed conic, the properties of spheres, of circular sections, and of confocal quadrics coming in in their natural place. The elements of the theory of the linear complex and of the tetrahedral complex are touched upon by the way. Chap. iii. treats of the space cubic curve, arising as the further intersection of two quadrics with a common generator, or obtained as the locus of intersection of corresponding planes of three related axial pencils.

A series of examples gives in summary form many properties of the curve and its construction to satisfy various sets of conditions; for example, it is shown that two general space cubics have ten common chords and that there are six space cubics having six arbitrary lines as chords. The theory of self-polar tetrads and of self-conjugate pentads and hexads on the curve is also developed.

The final chapter is introductory to the theory of the general cubic surface, which it is intended to discuss later in connexion with a configuration in four dimensions. The well-known double-six theorem is first investigated and examples are considered of the figure of twenty-seven lines arising therefrom. A geometrical definition of the cubic surface is then given, and it is shown that there are families of space cubics lying upon it. This leads to the representation of the surface upon a plane. Other matters which are summarised in this chapter are the reduction of the equation of the cubic surface to the sum of six or five cubes, the bitangents of a plane quartic curve, the Hessian surface of a cubic surface, the four-nodal cubic surface and its dual, the Steiner quartic surface.

This book, it is safe to prophesy, will become one of the most treasured possessions of the student of geometry.

F. P. W.

Our Bookshelf.

The Flora of the Malay Peninsula. By Henry N. Ridley. (Published under the Authority of the Government of the Straits Settlements and Federated Malay States.) Vol. 2: Gamopetalæ. Pp. vi+672. Vol. 3: Apetalæ. Pp. vi+406. (London: L. Reeve and Co., Ltd., 1924.) 42*s.* net each vol.

VOL. 1 of this series was noticed in NATURE of January 6, 1923, p. 6. Of Vols. 2 and 3 which have now appeared, the former deals with the Gamopetalæ from Caprifoliaceæ to Labiatæ, and the latter with the Apetalæ from Nyctagineæ to Salicineæ. The arrangement of the natural families is that of the "Genera Plantarum" except that in the second volume the Plantagineæ are inserted after the Plumbagineæ, and the Cardiopteridæ after the Convolvulaceæ. In the third volume the Aristolochiaceæ and Nepenthaceæ are transposed, the Hernandiaceæ are separated from the Laurineæ and the Opiliaceæ are included. The Urticaceæ are, however, still retained as one general family.

It is easy and perhaps somewhat ungenerous to criticise a work of the size and importance of this first complete flora of the Malay Peninsula. Moreover, it is rare that such an expert in field work as is Mr. Ridley should be equally at home in the herbarium, but it is undoubtedly due to this uncommon combination of capabilities that we find many points which are apt to provide difficulties to less fortunately equipped workers. For example, the contrasting in certain of the keys of comparative values only renders them valueless to a worker who may be in possession of one of the species only. Again, the frequent use of the abbreviation *l.c.* entails considerable search for the orginal quotation, and in the majority of cases is not a saving of space. Had the measurements been given in parts of a metre instead of tenths of an inch the work would have been more in accordance with present-day standards.

The work generally is of the nature of the old-time flora intended purely for the systematist. There must be a mass of information available which might have been indicated briefly, as for example on the ecology of the plants cited, for the very short extracts of field notes quoted are but little help to a worker who has not an intimate knowledge of the country and its vegetation. For workers in Malaya an index to the vernacular names cited would have been of great help, for in that country, where Malay is the common language, the plant names are first learnt in that language, and such an index would introduce the work to a much wider circle.

The references to the new species leave much to be desired. In the second volume there are one hundred and five and in the third volume twenty new species and new names given. The differential diagnosis is confined to a wholly inadequate line or mention in the key, and where the affinity lies with an extra-Malayan plant it is left to an occasional footnote to give assistance. Further, and what is perhaps worse, in scarcely any cases are specimens quoted, only collectors' names. The figures are well drawn by Mr. Hutchinson, and it is to be regretted that they are so limited in number. It is a pity there are so many minor imperfections to detract from the value of a work of first-class importance executed by an author with such a unique experience.

Differential Equations in Applied Chemistry. By Prof. Frank Lauren Hitchcock and Prof. Clark Shove Robinson. Pp. vi+110. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1923.) 7*s.* 6*d.* net.

THE problem of providing a student of one of the experimental sciences with a broad basis of mathematical knowledge coupled with the special technical facility in the subject required for the development of his own field is no mean one. Especially does it become acute, now that increasing demands of the teachers of his principal subject establish an ever-greater monopoly of his time during training. Hence, partly, the reason why so many chemistry, physics, biology, and engineering students return in later years to their mathematical masters for expert assistance: but this is not the whole truth. Teachers of mathematics must equally share the blame.

A reorganisation of mathematical teaching along "functional" lines is clearly indicated, and until that is undertaken seriously so that the methods are consciously directed to, and arrive at a concrete end with a detailed application to real and not "mathematician's" problems, much of our present teaching must be futile. The attitude of many teachers to their subject is false and cramped. In the introduction to this otherwise excellent book, for example, we are informed that the student (of chemistry) has two important needs in mathematical technique:

(1) How to integrate the differential equation.

(2) How to perform the calculations needed to obtain an answer correct within the practical requirements of the problem.

Now this would be excellent were it not for the fact that (2) *is* (1) in practice; it is the exception to encounter an equation that can be "integrated" in the sense that it belongs to one of the so-called "Standard Forms," and recourse must then generally be had to approximations, *i.e.* to (2). But it is just the processes included in (2) that receive the least attention, and it is exactly a discussion of the "Standard Forms" that usually delimits the scope of the knowledge of differential equations acquired by physical and chemical students. The reason is not far to seek. They owe their pedagogic prominence to the position given to them in the earliest books on "Differential Equations," and retained ever since. For certain branches of "functional" teaching in mathematics little would be lost by "scrapping" the lot.

The present little book is an heroic attempt to make the best of both worlds by restricting attention only to equations that are integrable and useful.

H. LEVY.

Smithsonian Miscellaneous Collections. Vol. 74, No. 1: *Smithsonian Mathematical Formulæ and Tables of Elliptic Functions.* Mathematical Formulæ prepared by Prof. Edwin P. Adams; Tables of Elliptic Functions prepared under the Direction of Sir George Greenhill by Col. R. L. Hippisley. (Publication 2672.) Pp. viii+314. (Washington: Smithsonian Institution.)

THIS volume contains, in addition to the series of formulas of many branches of applied mathematics prepared by Prof. E. P. Adams of Princeton, a table of the elliptic functions, with an illustrated discussion of their chief applications in geometry, dynamics, and electricity.

The table of the elliptic function was prepared and calculated by Col. R. L. Hippisley; it gives, in a form suitable for immediate application, the series of functions $A(r)$, $B(r)$, $C(r)$, $D(r)$, $E(r)$, $G(r)$, $F\phi$, for every degree r of the quadrant, and every degree θ of the modular angle, where $\sin\theta=\kappa$ the modulus. These had been calculated already for the British Association, and printed, but held up for want of money.

Here A, B, C, D are the theta functions of Jacobi, but normalised to zero degree, so that with $\frac{r}{90}=\frac{u}{K}$,

$$D(r)=\frac{\Theta u}{\Theta 0},\quad A(r)=\frac{Hu}{HK},\quad B(r)=A(90-r),\quad C(r)=D(90-r),$$

giving

$$\sqrt{\kappa'}\ \mathrm{sn}u=\frac{A(r)}{D(r)},\quad \mathrm{cn}u=\frac{B(r)}{D(r)},\quad \frac{\mathrm{dn}u}{\sqrt{\kappa'}}=\frac{C(r)}{D(r)}.$$

Also $\phi=\mathrm{am}u$ is the inverse function of $u=F\phi$ of Legendre; and his elliptic integral of the second kind $E\phi=\frac{rE}{90}+E(r)$, so that $E(r)=Zu$, or $\mathrm{zn}u$ of Jacobi.

Provided with these functions, the third elliptic integral Π can be expressed in a form that can be calculated numerically from the table, where the results are given to ten decimals.

Acoustics of Buildings: including Acoustics of Auditoriums and Sound-proofing of Rooms. By Prof. F. R. Watson. Pp. viii+155. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1923.) 15s. net.

THE acoustics of buildings is a subject which has always possessed importance, but with the increasing size of public buildings and the congestion of our urban populations, it has assumed much greater importance in recent decades. Though a good deal has been written on this subject, there are few books which present the problems to be solved in a lay form suitable for those not possessed of scientific attainments. Prof. Watson has succeeded in producing a volume which should prove of great value to architects concerned with the design or acoustic improvement of auditoriums, and has incorporated a number of his own researches. The volume is divided into three parts, a short introductory chapter on the principles of sound transmission scarcely deserving of a main separation, the acoustics of auditoriums, and the sound-proofing of buildings. In part 2, after explaining the behaviour of sound in a room, the nature and control of reverberation, the successful design of an auditorium and sound absorption are discussed, followed by a very interesting chapter on practical examples from existing buildings. Part 3 gives a number of experimental tests on materials by the author and others, followed by examples of sound-proofing rooms and buildings, and a special chapter on ventilation in reference to sound, while vibrations in buildings are shortly dealt with. The work is a successful attempt to bring the investigations of science to the aid of the artist and technician.

Practical Chemical Analysis of Blood: a Book designed as a Brief Survey of this Subject for Physicians and Laboratory Workers. By Prof. V. C. Myers. Second revised edition. Pp. 232. (London: Henry Kimpton, 1924.) 25s. net.

THE second edition of this book contains alterations and additions necessary to consider advances made in the subject during the last two years. An additional separate chapter gives the methods of blood analysis followed by Folin and Wu, and Benedict's new method of uric acid estimation is described. This edition also contains descriptions of the estimations of hæmoglobin, oxygen, calcium, inorganic phosphates, and acetone bodies, and a chapter on quantitative micro-methods of urine analysis. Numerous references to original articles, and appendices on colorimeters and standard solutions, perfect a valuable book on a subject of rapidly growing importance.

Nouvelles Vues Faraday-Maxwelliennes. Par Charles L.-R.-E. Mengès. Pp. v+94. (Paris: Gauthier-Villars et Cie., 1924.) 10 francs

M. MENGÈS reprints and expands some papers which have appeared in the *Comptes rendus* of the Paris Academy of Sciences, chiefly on the electro-optics of moving systems. He finds the special theory of relativity self-inconsistent and proposes in some measure to revert to the older "classical" conceptions. Nothing but a detailed and complete discussion of his views would be worth undertaking; and since it is impossible to find space for this here, we offer no opinion concerning them.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

A Possible Explanation of the Behaviour of the Hydrogen Lines in Giant Stars.

WHILE the general behaviour of the absorption lines in stellar spectra has been well accounted for by thermodynamic theory, the Balmer series shows marked peculiarities. In spite of the very high resonance potential, these lines appear even in stars of class G, and their intensity is conspicuously affected by absolute magnitude—that is, by the density of the stellar atmosphere.

According to the elementary theory, the fraction of all the hydrogen atoms present which are in the two-quantum state (and hence ready to absorb the Balmer series) should be $f_2 = q_2 e^{-(\chi_1-\chi_2)/kT}$, where k is Boltzmann's constant, $\chi_1 - \chi_2$ the resonance potential, and q_2 the weight of the two-quantum state[1]; and this fraction should be independent of the pressure. Introducing $\chi_1 - \chi_2 = 10{\cdot}16$ volts we find $f_2 = q_2 e^{-117000/T}$. For $T = 5000°$ (roughly corresponding to the outer atmosphere of the sun), $f_2 = 6 \times 10^{-11} . q_2$; for $T = 3000°$ (rather high for the corresponding region in an M-star), $f_2 = 8 \times 10^{-18} . q_2$; and even for $T = 10{,}000°$, $f_2 = 8 \times 10^{-6} . q_2$.

For comparison, we may take λ4481 of Mg+, for which $\chi_1 - \chi_2 = 8{\cdot}85$, and $f_2 = 1{\cdot}2 \times 10^{-9} . q_2$ if $T = 5000°$. Allowance for the fact that much of the magnesium in the sun is neutral may at most reduce f_2 to $10^{-10} . q_2$ of all the Mg atoms present. Now λ4481 and Hα are the strongest lines absorbed by atoms in the corresponding states; yet the former is barely visible in the solar spectrum, and the latter is one of the strongest lines of all. This would demand an absurdly great abundance of hydrogen relative to magnesium (itself an abundant element) if the effective values of q_2 were comparable. Moreover, in giant stars, and especially in super-giants, such as α Orionis and the Cepheid variables, the Balmer lines are very much stronger than in dwarf stars of the same general spectral class, though the temperatures of the latter are higher.

It appears necessary, therefore, to assume that the effective value of q_2 for the two-quantum state of hydrogen is increased, in some special way, by a very large factor, which increases as the pressure diminishes.

A tentative explanation may be found in the fact that one of the two two-quantum states of hydrogen is metastable. The state called 2_2 by Bohr (or $2p$ in the ordinary series notation) can pass to the normal $1_1(1s)$ state by emission of the resonance line λ1216; but an atom in the $2_1(2s)$ state can (so far as we know) get out of it only by the absorption of radiation, or else by a collision of the second kind with another atom or an electron. A similar condition is found in helium, where the 1σ state (the lowest in the doublet system) is metastable. There is direct evidence[2] that a helium atom may remain in this state for an average life of the order of 10^{-3} sec. or more, as against about 10^{-8} sec. for an excited atom which can get rid of its energy by radiation. The 2δ state for Mg+, concerned in the absorption of λ4481, is of the latter type.

If it may be assumed that the number of hydrogen atoms in the $2s$ state in a star's atmosphere, and hence the effective value of q_2, is greatly increased when the life of the metastable state is long, the peculiar behaviour of the Balmer lines becomes explicable. The increase in the concentration of absorbing atoms accounts for the strength of the lines; while collisions, which get the atoms back to normal and diminish this concentration, will be more frequent in the denser atmospheres of dwarf stars.

The average interval between collisions, in a gas of pressure p mm. and temperature T° K, between an atom of molecular weight m and radius r cm. and atoms of molecular weight m' and radius r' is

$$\frac{2{\cdot}24 \times 10^{-24}}{p(r+r')^2}\sqrt{\frac{mm'T}{m+m'}}.$$

For excited hydrogen atoms (for which $r = 2 \times 10^{-8}$ cm., $m = 1$) moving in a gas of temperature 5000° and pressure 0·1 mm. (roughly the conditions in the sun's reversing layer) the collision-interval comes out $1{\cdot}8 \times 10^{-4}$ sec. if the "other atoms" are ordinary hydrogen ($m = 1$, $r = 5 \times 10^{-9}$), and 9×10^{-6} sec. if they are electrons ($m = 1/1850$, $r = 0$). In a giant star, where the pressure is probably from ten to a hundred times less, these intervals would be correspondingly increased. They are evidently quite of the right order of magnitude to be dominant in determining the mean effective life of a metastable state such as has been observed in helium, and without influence on ordinary states.

The influence here suggested will be important only for atoms in metastable states of high energy content, which are more likely to lose energy than to gain it, even in collisions with other excited atoms.

We might therefore expect to find it for the familiar lines of helium. Here $\chi_1 = 24{\cdot}5$ and $\chi_2 = 4{\cdot}7$ for the 1σ state, so that f_2 should be $10^{-10} . q_2$ at 10,000° and $2 \times 10^{-7} . q_2$ at 15,000° (which is probably near the temperature at which the helium lines reach their greatest intensity). For λ4481, at 10,000°, $f_2 = 2{\cdot}8 \times 10^{-5} . q_2$. Here again the helium lines are stronger than might be expected from the probable abundance of the element (though the latter is hard to guess at). More definite evidence is found in super-giant stars like α Cygni, where the helium lines are present, though there is no trace of them in ordinary giants of Class A_2 or even A_0.

For the Pickering series of He+, $\chi_1 = 54{\cdot}2$, $\chi_2 = 3{\cdot}4$ and $f_2 = 6 \times 10^{-9} . q_2$ even at 30,000°, so that the argument from abundance would appear to be applicable.

The red triplet of oxygen, λ7772-75, for which the excitation potential is almost the same as for the Balmer series, should be strengthened in giant stars and Cepheids, and would be interesting to observe.

The great concentration of atoms in metastable states, which is here postulated, would not be expected to occur in a gas in thermodynamic equilibrium. Such concentrations have, however, often been observed experimentally in vacuum tubes, which are of course very far from being in such equilibrium. Whether the departure from equilibrium in stellar atmospheres, which undoubtedly exists, would permit a sufficient concentration to explain the observed facts in the manner here suggested may prove a problem of interest to theoretical investigators.

An observational test appears, however, to be possible. The supposed concentration affects only the $2s$ state of hydrogen, and not the $2p$ state. Of the three components of Hα, $2s - 3p$ is at 6564·516 (I.A.), $2p - 3s$ at 6564·658, and $2p - 3d$ at 6564·720. In the laboratory, the components of longer wave-length are the stronger. In the stars, that of shortest wave-length should, on our hypothesis, greatly predominate

There is no hope of resolution of this group in the

[1] Fowler and Milne, M.N., R.A.S., 83, 403, 1923.
[2] F. M. Kannenstine, *Ap. J.*, 55, 345, 1922.

stars, and measurement of the mean wave-length of the blend is greatly complicated by the effects of radial velocity, and of the "K term." The latter unfortunately indicates a shift in the opposite direction.

Even in the sun, radial velocity may greatly complicate the investigation. Could the Hα line be observed double in the prominences—or show to appear single when a pair of separation 0·15 Å would certainly be resolved—the question might be settled.

K. T. COMPTON.
H. N. RUSSELL.

Princeton University,
June 21.

Leaf-mould.

IT must be a matter of common knowledge to persons interested in woodlands that some woods and copses have a more or less thick deposit of leaf-mould, whilst in others this covering is absent. It is not a question of the presence or absence of particular trees, *e.g.* oak or beech, and it often happens that within the limits of a single wood considerable differences exist, in respect of leaf-mould formation, in different parts of it.

I have noticed that its presence or absence is very commonly correlated with the character of the surface soil. Sand or gravel promotes, whilst heavy, and especially calcareous, soils seem to inhibit its formation. In a small wood that I have had under observation for a number of years the surface varies from chalk to heavy clay, with a good deal of intermediate calcareous loam. Leaf-mould never forms naturally in this wood, although the conditions would seem to be generally favourable The trees are reasonably thick, consisting mainly of beech and some oak. The ground is well drained and dry for the most part, whilst in other spots it is damp and even boggy. There are large hollows where leaves collect, and from which the winds never move them, even in winter. But no real leaf-mould ever forms. The mass of dead leaves and twigs rot down and evaporate, so to speak, next year. This is to be attributed to bacterial action, and I believe that for the most part the result is due to the bacteria being able to carry on the disintegration process, mainly to carbon dioxide and water, in the presence of the available calcium carbonate of the surface soil. In another wood near by there are deposits of sand and gravel overlying the loams and chalk, and there the abundance of leaf-mould is very striking.

It occurred to me that the presence of the "acid" silicious top soil might be the decisive factor in the situation. Such an acid soil, by not neutralising the products of bacterial action, would conduce to the arrest of bacterial activity and so might provide in the first-named wood the requisite condition for leaf-mould formation which had, up to that time, been lacking This hypothesis received confirmation. A covering of sandy gravel spread over the surface of one of the hollows was followed by the formation of an excellent leaf-mould, though this had not occurred in this hollow before, nor did it take place at all in those hollows adjacent to it which had not received a coat of gravel.

I do not suppose that the whole story of leaf-mould formation is contained in the foregoing, and it may well be that in other situations additional or other factors are concerned. Indeed it seems certain that soil drainage also influences the process, perhaps through its affecting conditions of suitable aeration. At any rate it happens that when pans of clay occur near the surface of a gravel or sandy soil in woods, with the result that the ground is water-logged for a part of the year—in such places one looks in vain for leaf-mould, though a black peaty deposit may occur in its place. These peaty deposits are very different from genuine leaf-mould, though both owe their origin to the disintegration of vegetable matter.

Leaf-mould, regarded from the point of view of the succession of organisms that are concerned in its production, and of the complex chemical changes therein involved, offers an attractive field for research. It is perhaps scarcely necessary to emphasise the fact that in addition to problems of more purely scientific interest, there are others connected with it which are of industrial importance as well. J. B. FARMER.

Imperial College of Science and Technology,
South Kensington, S.W.7.

The Theory of Hearing.

REFERRING to Prof Scripture's letter in NATURE, June 28, the following observations on the vowel response of piano strings, which differ from those described, may be worth recording.

Using a small Broadwood upright piano with the lid open, and singing or speaking well into the instrument, I have found, (1) That a recognisable vowel response is given to *all* the English vowel sounds, though those to *i* (as in eat) and I (as in it) are relatively faint, owing to the poor response of the strings to frequencies of 2000 and more.

(2) That the response *is* given almost equally well, whether the vowels be intoned as prolonged or as relatively instantaneous sounds.

(3) That quite a good response is given to vowels sung "portamento" (with a variation of pitch of about an octave) or spoken as short sounds of varying laryngeal pitch. In some cases, especially in that of *u* (who), the "portamento" response is quite as good as that for the same vowel when intoned at constant pitch.

Experiment shows that a vibrating rubber strip "larynx," attached to a double resonator, will produce a constant vowel sound while the frequency of the larynx note is varied over an octave or more, by variation of the air pressure supplied to the larynx.

It seems reasonable to suppose that, in the production of a "portamento" vowel sound in the human mouth, the same thing applies—*i.e.* that the resonance frequencies of the vocal cavity remain substantially constant, though the frequency of the laryngeal puffs which evoke them is progressively changing. R. A. S. PAGET.

74 Strand, London, W.C.2.

IN reply to Prof. Scripture's letter in NATURE of June 28, I am not able to discuss the more recondite points he raises as to the nature of vowel sounds, or the mathematical formulæ by which alone, as he states, they can be subjected to analysis. I cannot, however, accept his statement that the undamped piano strings fail to respond to short spoken vowels. The facts can be tested in a moment by any one who has access to a piano. The fuller the tone of the instrument the clearer will be the response.

My own observation is that one gets a recognisable and distinguishable vowel however short the utterance, and that the quality of the resonated vowel is not noticeably changed by shortening or lengthening the vocalisation of the vowel sound; and further, that the characteristics of the vowels are as clearly distinguishable in the sharply uttered as in the sung vowel: ā, ă, ı, oe, oo, all seem to come out fairly clearly and distinguishably. As Helmholtz says, the

ee is not so good. I believe this vowel contains high-pitched partials. The effect is improved by directing the voice rather more to the upper end of the sounding board so as to bring out these particular partials. The deduction that one would naturally draw from this simple experiment is that the vowels do contain musical partials, capable of being resonated so as to produce a combination of tones which is characteristic of the particular vowel employed. Of course the vowels may also contain other constituents which are incapable of being resonated, at all events by so imperfect a resonator as a piano.

The two fundamental points on which we are at issue appear to me to be these: (1) Are noises, as distinct from musical sounds, capable of being analysed by a series of resonators? (2) Are sounds of rapidly changing pitch capable of such analysis? In answering the first of these propositions in the negative, is not Prof. Scripture assuming that the limitations of analysis by Fourier's theorem and of analysis by resonators are the same? Fourier's theorem is by definition restricted to the case of recurring wave forms, *i.e.* (so far as concerns the present discussion) musical sounds, and to their analysis into fundamentals and harmonic partials. But is not this restriction imposed upon mathematicians by reason of the fact that the permutations and combinations possible when inharmonic partials are admitted are practically infinite, and consequently defy mathematical analysis? May not all sound waves be looked upon as being compounded of simple harmonic vibrations and consequently theoretically capable of analysis into their constituents? If it be admitted for the moment that the fibres of the basilar membrane with their associated fluid columns in the cochlea do actually form a complete series of resonators, any succession of pressure changes communicated to the fluid in the cochlea will set in harmonic vibration a certain number of transverse sectors of the membrane. If the components of the exciting wave are harmonic, the sectors of the membrane set in vibration will be narrow bands definitely spaced, and the result will be the sensation of a compound musical tone. If they are inharmonic the tendency will be for the different vibrating sectors to overlap so as to form vibrating *areas* with no distinguishable maximum point, and we should then have a sensation of noise of indefinite pitch.

With regard to the possibility of the resonance of inharmonic partials, inharmonic tones sounded simultaneously on a musical instrument are capable of being analysed by resonators. How then can it be maintained that inharmonic partials from a single source are not amenable to a similar analysis?

In the case of sounds of rapidly changing pitch, the completeness with which they can be analysed will depend partly on the relation of the rate of change of pitch to the periodicity of the vibrations, and partly on the degree of damping of the resonators. To speak of "damped" and "undamped" resonators, as Prof. Scripture does, seems to be rather a loose use of terms. There are no absolutely "damped" or "undamped" resonators (so far as sound is concerned). Resonators are of all degrees of damping. The cochlea is rather heavily damped, and consequently the location of resonant response in it may be changed much more rapidly than in the case of piano strings. (The silencing of piano strings when the "dampers" are down is not damping in this sense at all).

In Dr. Hartridge's pendulum experiment (NATURE, May 17, p. 713) the vibration period of the pendulums is much longer than that of sound waves. The alteration of the length of the driving pendulum must therefore be much slower than in the case of change of pitch of a musical sound if a "jangle" is to be avoided. But in Prof. Scripture's example of the Savart's wheel, or siren, which is being speeded up, if the speeding is done very rapidly the result is a disagreeable noise, which probably results from some such irregular jangle of vibrations in the cochlea as is seen in the pendulum experiment when the rate of vibration is altered too rapidly.

Still it must be conceded that the question of degree of damping and sharpness of resonance in the cochlea is the most difficult factor in the resonance hypothesis. It is far too complicated a problem to be discussed adequately in the limits of a short letter.

GEORGE WILKINSON.

Sheffield.

Specular Reflection of X-rays.

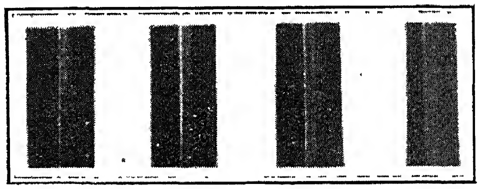
LORENZ has developed the approximate expression for the index of refraction of X-rays

$$\mu = 1 - \frac{ne^2}{2\pi m v^2},$$

where "n" is the number of electrons per unit volume and "e" and "m" refer to the charge and mass of the electron. This expression would indicate that at very small angles X-rays should be totally reflected by the refracting medium. The critical glancing angle is given by the formula

$$\sin\theta = \sqrt{2(1-\mu)}.$$

A. H. Compton in the June 1923 issue of the *Philosophical Magazine* shows that he finds this reflection and that it is truly total reflection. His work was done by the ionisation chamber method.



6′ 8′ 10′ 12′

FIG. 1.

I have repeated his experiment by the photographic method, reflecting the general radiation of a molybdenum tube from crown glass. The arrangement of the apparatus differed somewhat from his. The radiation passed through a slit about 0·5 mm. wide and fell upon the surface of the glass, which was mounted on a spectrometer table. In order to obtain a sufficiently narrow beam of X-rays, the width of the beam was limited by mounting a piece of lead on the spectrometer table and pushing it as close to the glass as was necessary. The zero position of the glass was located by trial, it being taken as the position in which the primary beam was most intense. The photographic film and the slit were both 31 cm. from the centre of the glass. The angle through which the reflecting surface was rotated was measured on the spectrometer table. Angular separation on the film was twice the angle of rotation. The exposures for the reflected beam were ten minutes.

Reflection was obtained at the angles 6′, 8′, 10′, 12′. The intensity at the first three was approximately equal; at 12′ it was much less (Fig. 1). The reflected beam disappeared at 14′. These results are in accord with Compton's. The intensity of the reflected beam in this work, however, is not equal to that of the primary, being less than 20 per cent. as great. This

is probably due to the fact that the energy of the radiation from a molybdenum tube is largely concentrated in wave-lengths of about 0·4 and of about 0·7 Å.U., which have a very small critical angle. It was the longer wave-lengths, those in the region of 1 Å.U. and more, that were reflected at the angles of this experiment. This difference in intensity, therefore, is not contrary to Compton's results.

H. E. Stauss.

Physics Laboratory, Washington University, St. Louis, U.S.A., June 13.

Science and Labour.

It was obviously impossible in the general article in Nature of June 14, on the Science and Labour Conference held at Wembley last month, to devote more than a few lines to any speaker; but for this reason I have been asked by representatives of certain research associations to correct an impression which might be gathered from the summary of my remarks concerning those associations, for the initiation of which previous governments were responsible.

In justice to the scientific workers in those associations, I should be glad if I might be permitted to explain that my criticisms were levelled against the suggestion contained in the last published report of the Advisory Committee of the Privy Council on Scientific and Industrial Research, that unless more financial support were forthcoming from the manufacturers' associations, the Government could not continue them after the expiration of the original contractual period of five years.

To my mind this amounts to a confession of the failure of the *policy* of the Advisory Committee and of the failure of a great many industries to realise the importance of research. In the first place, if the policy was to succeed, the research associations should have been given a much longer period of support. Five years is a short time to devote to most important problems in research, and even when they are solved there is abundant evidence that it takes many more years for the solutions to be applied, through no fault of the research worker, and sometimes through no fault of the manufacturers.

If the idea of co-operative research for groups of manufacturers is dropped, then, however important and commercially valuable the research already done may be, the primary object has not been achieved, and in that sense the money devoted to that object has been lost. I believe, in common with the members of the Research Committee of the National Union of Scientific Workers, that research must be fostered, and the staffs who have devoted their past few years to industrial research must be protected and kept together, with or without the financial support of the manufacturers, for industry exists for the nation and not primarily for the manufacturers. I believe the policy was wrong initially and the machinery defective, but it would be disastrous if the knowledge and the experience gained by the competent research workers were not utilised for the country. A. G. Church.

House of Commons.

Birds as a Geological Agent.

Mr. Martin has directed attention in Nature of July 5, p. 12, to the fact that birds may carry shell-fish to heights considerably above sea-level, and I remember as a student being warned against a too ready assumption of elevation of the land relatively to the sea founded on the occurrence of remains of mollusca above high-water mark. But the operations of birds in the past history of the world were probably far more extensive. Their efficiency in the distribution of seeds and minute organisms over seas is now generally acknowledged, and of course we are indebted to birds for valuable deposits of guano.

It is possible, however, that they may have played an even more important part in the destruction of other forms of life. The evolution of highly predacious sea-birds in later Mesozoic times must have been fatal to many types which had been developed without provision for protection against such foes, and it seems possible that the cessation of so many groups at the close of the Cretaceous period may be attributed to this cause. The cephalopods whose careers then came to an end would appear to have passed much of their time at the surface of the sea, where they would be an easy prey. At the same time the eggs and young of many reptiles would also be exposed to attack. The chelonians may have survived because they buried their eggs, as they do still.

Prof. Bonney suggested that it was our ancestors, the small primitive mammals, that disposed of their reptile enemies in this way. It may have been, but I cannot help thinking that the Hesperornis and its comrades were better equipped for the task. The Archæopteryx and the pterodactyls were older and presumably less efficient denizens of the air.

J. W. Evans.

Imperial College of Science and Technology, S. Kensington, S.W.7, July 7.

The Atlantic Salmon in New Zealand.

An event of importance in the history of the acclimatisation of Salmonidæ has just recently been noted in New Zealand. For nearly sixty years New Zealand and Australia have been endeavouring to acclimatise the Atlantic salmon. (It is of interest to note that the quinnat salmon from the Californian coast is now thoroughly established in the South Island of New Zealand; recently I have identified examples from the south of the North Island.)

Fisheries' inspectors and anglers have reported that for the last two or three years *Salmo salar* was to be taken in large numbers in Lake Te Anau in Otago; but no specimens had been seen by me until recently, when Wellington fishermen took an alleged quinnat salmon in Cook Strait. This fish was examined and found to agree in most essential respects, notably the disposition of the teeth, with descriptions of *Salmo salar*. The scales, however, were smaller than commonly found by European observers. An interesting question to be decided in the future is whether we have developed our own *Salmo salar novæ-zealandiæ*, or whether we have here a chance variety which readily adapts itself to the environment.

Cook Strait is equivalent in latitude to the Spanish coast or northern part of the Mediterranean. So far as is known to science, the specimen above noted is the first Atlantic salmon ever taken in the sea in the Southern Hemisphere.

William J. Phillipps.

Dominion Museum, Wellington, N.Z.

The Isotope Effect in Line and Band Spectra.

In a recent letter to Nature (June 7, p. 820) the use of quotation marks around the word "theory" in the fourth paragraph conveys an impression which was not intended. In the original manuscript the word was underlined, meaning that it should be italicised; but apparently this was misunderstood, and quotation marks were used instead.

Robert S. Mulliken.

Jefferson Physical Laboratory, Harvard University, Cambridge, Mass.

Mountain Sickness.

By Prof. JOSEPH BARCROFT, F.R.S.

SCIENTIFIC men, according to no less an authority than Longstaffe, were the pioneers of mountaineering. Its vogue as a sport followed. "During the latter part of the eighteenth century, that great period of awakening interest and research into physical science, mountain ascents were encouraged and performed only by scientific men. Such men, practical observers, and expecting to be severely affected by what we consider to be only moderate diminutions in atmospheric pressure, noted even the smallest abnormal symptoms in themselves. . . . On the other hand, during the last fifty years mountaineering has become a sport and is practised by a much larger and very different class, although it is true that many men of scientific attainments are to be found among the ranks of the modern mountaineer."

The question naturally arises: why did the ascent of mountains awaken such keen interest in the scientific men of bygone days? And it is followed by another, namely: what has been the fruit of their researches? Those were the days in which almost nothing was known about the causation of disease—in fact it is difficult to realise how little was known on this subject even so recently as falls within the memory of the still middle-aged. I cannot say what may be the limits of middle age, but I know many men born in the early 'seventies who would account themselves young rather than old, and yet if we look back to, say 1872, and ask ourselves what was then known about the causation of disease, the answer is instructive enough. Since that date the whole science of bacteriology has arisen and has enlightened us as to the cause of innumerable complaints, the micro-organisms of which are known, and by analogy as to a number of others attributable to a flora as yet undiscovered. Then there are all the diseases which are caused by trypanosomes and other parasites, the life histories of which have been worked out; the hosts which transport them have been recognised, and therefore the mechanism of their causation is understood. Or, again, consider such troubles as swollen joints, which scarcely rank among the epidemics, and yet in how many cases are they caused by micro-organisms which can be recognised. In 1872 all these things were unknown, and therefore a pathological condition which could be pinned down to an evident cause was a *rara avis* among diseases.

Such was mountain sickness: by ascending you could acquire it, and, what was perhaps more remarkable, by descending you could, within limits, throw it off. Such was the interest which, as I make out, it held for scientific men.

Mountain sickness is called in the Peruvian Andes "seroche," and the fact that it is given a definite name, which appears in medical cyclopædias, coupled with the natural scepticism of the scientific inquirer, leads to the question, "Is mountain sickness a definite medical entity?" The question is the more pertinent because its manifestations differ greatly in different individuals —differ in degree and in kind. Dr. Alfred C. Redfield, in a paper read to an American society, the manuscript of which he kindly sent me, has stated the claim of "seroche" to a place among human maladies so clearly that I can do no better than quote him. "So definite," he says, "is its symptomatology, so general is its occurrence in these not unpopulous regions, that it deserves some attention as a clinical entity. Its severity is sufficient to give it, in connexion with the mining industry, a certain economic importance. While a few men were met who had never felt it, and many who had suffered but mildly, a very large number are so greatly affected as to be completely incapacitated for several days. In at least one authentic instance the 'seroche' of a normal healthy individual has been terminated by death. Each case is an individual story and up to the present no one has been able to predict who will and who will not be affected. A description of cases of two degrees of severity will serve to picture the chief features of the disorder. Making the ascent by train,[1] one lightly touched by 'seroche' experiences his first symptoms at an altitude of 10,000 feet or more. Subjectively lassitude, then headache, usually frontal, growing in severity, and perhaps nausea, are felt. One feels cold, particularly in the extremities, the pulse quickens, respiration becomes deeper and more frequent, the face is pallid, lips and nails are cyanotic. On descending from the summit to Oroya (12,000 ft.), though a marked improvement is felt one finds himself reduced to a helpless condition of weakness which renders the least muscular effort irksome and productive of shortness of breath, dizziness and palpitation. The night's sleep is restless, and on waking one feels much as he does on venturing to his feet after recovering from an acute infection. In two or three days one's strength returns, the colour improves somewhat, and all but the more severe forms of exertion may be taken without distress. The majority are less fortunate than this. During the ascent, the symptoms are qualitatively the same, but frequently more severe, and nausea gives way to vomiting. The night's sleep fails to bring relief. Severe headache, gastro-intestinal instability, and weakness continue for several days; the body temperature may be supra-normal (102° F. in the rectum) and at times one is aware of palpitation. Cyanosis is marked. After three or four days in bed relief comes, and in a week normal activity may be resumed."

There is probably more unanimity now than at any other time as to the cause of "seroche," for there can be few, if any, men of science who do not attribute it to deficiency of oxygen. At an altitude of about 14,200 feet, the barometer stands at 457 mm., and the partial pressure of oxygen in the air cells of the human lung is just about half the normal—about 50-55 mm. instead of 100-110.

During the century and a half which have elapsed since the time when, according to Longstaffe, scientific men commenced to make observations upon mountain sickness, opinion as to the cause of the complaint has vacillated a good deal. Two theories have been serious competitors to that stated above, and they have come from very different sources: one was the invention of the distinguished physiologist, Mosso;

[1] Of the Central Railway of Peru. The train leaves Callao at the sea level about 6 A.M. and reaches the summit, 15,885 feet in altitude, near the station of Ticlio, about 3 P.M. the same afternoon.

the other was due to the entrance of the sportsman into mountaineering. Let me first discuss the latter of these two theories; it is that mountain sickness is due to a combination of fatigue, cold, bad feeding, and other discomforts incident to attempts by unfit or unathletic men to climb mountains which are beyond their physical powers.

I yield to none in my esteem of the "modern mountaineer," but, with all due respect, I would submit that he is the last person whose opinion on this subject is of value, and I have no difficulty in "stating my reasons in writing." It is of the nature of all sound scientific investigation that, in seeking out the cause of any phenomenon, only one variable should be altered at a time. Of the four variables, temperature, physical exertion, diet, and oxygen pressure, the Alpine rock climber alters all simultaneously and then pronounces to which the "seroche," if felt, is to be attributed. If you wish to see mountain sickness, do not study it among trained athletes in the Alps, whose very training makes them abnormal beings, who can only attain the rather moderate altitudes on European mountains by the performance of notable feats of physical prowess combined with exposure to extreme cold and long periods spent without a normal meal. If you wish to find out whether or no "seroche" is due to oxygen want, go to some place at which the alteration in oxygen pressure can be attained by all and sundry for a sufficient time to bring on the symptoms, but without the complications to which reference has been made. Of these localities, Pike's Peak in Colorado is good, but the best is undoubtedly that to which reference has already been made, namely, the Ticlio summit on the Central Railway of Peru.

There (year in, year out), on any of the six working days of the week, you may see a train full of passengers arrive; and if you see what I saw at Ticlio station, it will be two long coaches of the Pullman type with a head extended from each window, for, as Dr. Redfield truly says, "The majority are less fortunate . . . nausea gives way to vomiting." Here is a train load of persons, Indian, half-breed, Peruvian, European, who have been transported, if going east, from the sea level in eight or nine hours with no effort to themselves. They have had hot meals on the way, for the principal occupation of the inhabitants of the town of Matucana, at an altitude of 7700 feet, appears to be that of feeding the passengers on the train. They have not been subjected to cold; Ticlio itself is not above the snow line, though about the height of the summit of Mt. Blanc, and even if it were, the train (or at least the compartment in which I was) was heated by a stove. There, and not in the Alps, you see the clean experiment; but the truth is that you may see it without going so far afield. Many laboratories contain respiration chambers of one sort or another in which the partial pressure of oxygen may be reduced either by exhaustion, as at the Consumptive Hospital at Brompton, or in Prof. Dreyer's laboratory at Oxford, or by partial replacement of the oxygen by an indifferent gas, such as may be done in the chambers used by Dr. Haldane and by his workers in the Cambridge Physiological Laboratory. In this last-named structure it has been my unhappy fate to suffer the classical symptoms of "seroche." The pressure of oxygen was decreased from day to day till it fell to that which corresponded to an altitude of 18,000 feet. After sleeping (I use the word rather euphemistically) the night in that atmosphere, I arose to make the usual analysis of the air which was my first duty each morning. I was scarcely out of bed before vomiting set in, I suffered from an intense headache, and gas analysis was a matter of great difficulty; by an effort of concentration I could read the graduations on the gas burette, but all outside the very centre of the field of vision was a blur.

The theory of Mosso that "seroche" is due to acapnia, or insufficient carbonic acid dissolved in the tissues of the body, is not seriously now held.

Taking it, therefore, as settled that mountain sickness is due to oxygen want, the question arises, "Oxygen want of what?" And the answer is, "Of the brain."

Such evidence as is at our disposal goes to show that the brain wants but little oxygen; that little, however, it wants very badly indeed. Complete deprivation of oxygen would abolish consciousness in a matter of a few seconds. An appreciable inadequacy in the supply produces the symptoms which Dr. Redfield has enumerated. These symptoms are manifested by many organs in the body, but a careful scrutiny of them shows that they are essentially not the effects of want of oxygen on the organs themselves, but they are evidence of deficient oxygen supply to the centres in the medulla oblongata which govern the activities of these organs. Let me take a single example, that of palpitation of the heart. The effects of oxygen want on the vertebrate heart when isolated and kept beating outside the body are slowing and ultimate cessation of the beat, and a lengthening of the time which elapses between the auricular and the ventricular contractions. Yet the effect of insufficient oxygen on the heart beat in the human body is just the opposite. Dr. Somerville stated in an account of the doings of the 1922 Everest Expedition, at the Royal Society of Medicine, that on the day on which he approached 27,000 altitude his pulse was about 200 "all day" (this last phrase colloquially).

Such a phenomenon may be due to lack of vagus control over the heart, or it may be due to asphyxial nervous stimulation of the suprarenals through the sympathetic system or to direct sympathetic stimulation, or to all together, but it is not the direct effect of oxygen on the heart tissue. Yet this nervous quickening of the heart may have results which are far-reaching enough. The only observations of which I know on the circulation in a case in which the heart beat at 200 were made on a student in the Cambridge Laboratory who suffered from occasional attacks of paroxysmal tachycardia. The heart in these attacks became very inefficient, only driving about half the normal quantity of blood round the body, and almost none through the skin, which therefore became very cold. Such a condition on Everest would court frost-bite in circumstances when already it is difficult enough to cope with the cold. In this last connexion it is very interesting to note, in the experience of the Everest party, the breathing of oxygen at once brought a glow of warmth to the skin.

So it is with the other symptoms; the vomiting is no doubt the effect of oxygen want, not in the alimentary

canal but in the brain; the breathlessness also is a medullary effect, but it at least has a beneficent aspect, for the greater the quantity of air passed through the lungs (other things being equal) the higher the oxygen pressure in the air-cells, and therefore the less the tendency to mountain sickness.

We may conclude with a few sentences on the subject of acclimatisation. In an article in NATURE on the return of the Cerro de Pasco Expedition nearly two years ago (vol. 110, p. 152, July 29, 1922), I have already discussed acclimatisation in some detail. So far as the observers on that expedition could judge, the factors in acclimatisation were, as had been found by previous workers, of two categories, those which tended to increase the pressure of oxygen in the arterial blood, and those which tended to increase the quantity of oxygen which each cubic centimetre of blood carried at any specified pressure. In the latter category are (1) the increase in the number of corpuscles in each cubic centimetre of blood coupled with a corresponding increase in the hæmoglobin; (2) an increase in the affinity of the hæmoglobin for oxygen, which is probably caused by a greater alkalinity of the interior of the red corpuscle.

Among the factors which tend to increase the pressure of oxygen in the alveoli of the lung, and so of the arterial blood, is the increase in the volume of air passed through the lungs. Probably the peculiar size and shape of the chest of the native inhabitants of the Peruvian Andes tends in the same direction. A native whose height is sixty-one inches has a chest of about the same size as a European of seventy inches in stature. No account of the factors concerned in acclimatisation can be complete without reference to a possible one, namely, a more copious blood supply to the medulla. Stress has already been laid upon the fact that symptoms of mountain sickness are medullary, and more accurate knowledge is desirable of the factors which govern the blood supply of this part of the brain. Since our return from Peru, however, the work of Roberts has shown that the medullary blood supply is not simply the toy of circumstances, but is under the control of the brain itself.

Insects and Flowers.

By Dr. E. J. SALISBURY.

THE more definite relationships which subsist between organism and organism, whether it be between the algal and fungal partners of the lichen complex; between the forest tree, the orchid, or the gentian and their respective mycorrhiza; or between the Planarian worm *Convoluta Roscoffensis* and the alga Carteria, all alike bring home to one the delicacy of biotic relationships and the efficiency of whatever be the *modus operandi* of the evolutionary process. The relation between entomophilous flowers and the insects through the agency of which their pollination is effected constitutes no less remarkable an example of mutual specialisation than those already cited. It is scarcely surprising that the subject has attracted the attention of a considerable number of investigators from the observational period rendered notable by the publications of Koelreuter (1761), Delpino (1867), Mueller (1883), Darwin (1876), Kerner (1876), and Knuth (1898), to the experimental period of modern times initiated by the extensive researches of Plateau (1877–1910), and so ably followed by Lubbock (1882), Frisch (1913–19), Knoll (1919–22), and the work of Clements and Long, which has prompted and is the basis of the present article.[1]

The problems involved, though they admit of approach from either the botanical or the entomological point of view, can only be appreciated adequately if the interaction and interdependence of plant and animal be constantly before the investigator's mind. On the other hand, the earlier writers often obscured important issues by too teleological an attitude, as in the assumption that nectaries had been developed as organs of attraction for insects, whereas it is probable that, as the writer suggested fifteen years ago, all nectaries, both floral and extrafloral, originated as osmotic hydathodes and have secondarily acquired biological significance in relation to pollination. Occasionally extrafloral nectaries may themselves be important sources of honey supply, as has recently been noted for the partridge pea, *Cassia chamaecrista* (*Dixie Beekeeper*, 1922).

Every one recognises that insects, and especially bees, visit flowers for either honey or pollen, and that the process of pollination is incidental thereto. That this result ensues is the outcome of two factors, namely, the efficiency of the flower and the efficiency of the insect. With respect to floral structure, it is significant that, when closely related actinomorphic and zygomorphic types are compared, the latter are usually found to exhibit a reduction in the number of stamens and not infrequently in the ovary also; a reduction that could scarcely have come about without detriment to the race, but for the increased precision of the pollination mechanism which the zygomorphic form ensures.

It is, however, too often forgotten that pollen wastage would be enormous and insect agency almost as precarious as anemophily, were it not for the habit which bees in particular exhibit, of restricting their attentions, on a given flight, to a particular species of flower. Aristotle commented on this disposition, but the evidence respecting the degree of constancy seems to be somewhat conflicting, largely perhaps owing to lack of discrimination between the behaviour of the individual and the behaviour of the species. The observations of Clements and Long, for example, showed that the bumble bee, *Bombus juxtus*, visits at least twenty-seven species of flowers belonging to as many as twenty-two genera, and including such varied and specialised types of floral mechanism as Aconitum, Monarda, Thermopsis, and Gentiana. But when attention is confined to single individuals of this same species, the apparent fickleness of behaviour is seen to be illusory. This is sufficiently shown by the examinations of the pollen loads of twenty-five individuals of *Bombus juxtus* carried out by these investigators. Of these loads, nineteen consisted of one type of pollen only, whilst the remaining six were mixed pollen. Similar examinations of thirty-one honey-bees yielded

[1] "Experimental Pollination: an Outline of the Ecology of Flowers and Insects." By F. E. Clements and F. L. Long. Pp. vii.+274, with 17 Plates. Carnegie Institution, Washington. 4.00 dollars.

twenty-eight pure loads and three mixed loads. This high degree of constancy is not, however, always maintained with respect to the collection of nectar. The male bees, which in common with the Lepidoptera visit flowers mainly for nectar, may visit a variety of flowers even in a single flight, though constancy to one species is the general rule.

Numerous experiments in which flowers were placed in competition with one another as attractions to bees seem to show that these insects are remarkably constant to particular flowers, and that this is largely a matter of habit which tends to be perpetuated and developed owing to the increased dexterity resulting from practice. Mueller (1881) believed that the behaviour of bees indicated a psychological differentiation between the sexes, the males visiting the most accessible and fragrant flowers, whilst the thrifty females visit those which give the greatest yield of honey.

Admitting then the fact of constancy (oligotropism), it remains to inquire how the bee is attracted to the flower from a distance and on what features its taxonomic discrimination depends. The extensive experiments of Plateau, in which he employed artificial flowers of extreme perfection, showed that such are usually completely ignored, even though placed amongst their natural prototypes. The conclusion seems warranted that the perception of form and texture by bees is extremely acute. Experiments performed by Allard with the flowers of the cotton plant showed that Melissodes also has considerable discrimination with respect to structural detail. The story, recorded by F. P. Bedford, of the cabbage white butterfly which followed the artificial lilies of the valley on a lady's hat down a London street is scarcely less remarkable than that of the bee which flew to a coloured botanical wall-chart! The implied compliments in such occurrences are, however, more imaginary than real and bear testimony rather to the importance of colour and conspicuity as attractive devices than to the verisimilitude of the artifacts employed.

The experiments performed by Lubbock, in which he employed glass slips bearing honey and resting on variously coloured papers, indicated not only a preference of bees for blue, but also their colour-memory. Mueller and Lovell both obtained similar results, whilst the recent comprehensive study of Frisch (*Ver. Deut. Zoo. Ges.*, 1914), in which the range of colours was supplemented by numerous shades of grey, fully confirmed Lubbock's conclusion that bees recognise colour as such, and showed further that though distinguishing nuances of colour, there is a certain confusion similar to that of human beings colour blind to red and green.

Several investigators have shown that bees can be trained to visit a certain colour and exhibit association of impressions in a marked degree. Turner's experiments (1911) with diverse colour patterns demonstrated that amongst a mixed assemblage of these, bees usually return to the pattern to which they had become habituated. It is significant that the failures which have been experienced in the training of bees were associated with attempts to train for pure red and blue-green, unpleasant odours and geometrical patterns; that is, in respect to characteristics seldom if ever encountered by the bee under natural conditions.

It would seem to be fairly well established that colour and conspicuity are important agents of attraction up to a distance of ten metres, whilst the memory of a particular form and the less powerful odours, or their associations, serve as guides over smaller ranges of distance.

When several colour varieties of a given species are grown in proximity to one another, bees appear to visit them indifferently, which shows that form-association may predominate over colour-association. But the case of Pulmonaria shows that when colour differences are important, they are as much regarded as form. Bees visit the pink flowers of this plant freely, whereas when the corolla has turned blue, at which stage the flow of nectar has practically ceased, the flowers are neglected.

Clements and Long employed natural flowers of a variety of species, which they painted with water-colours and observed 420 visits to them as against 845 visits to the unpainted flowers. When artificial flowers were used, however, the number of visits was only about 12 per cent. of those to natural flowers, and in no case was a honey-bee deceived in this way. But, whilst this attests to the delicate perception of form, the frequent inspections made of the artificial flowers show that minute differences of structure are only detected at close range.

That vision plays an important part in influencing the flight of bees is shown by the tests on the so-called "homing" instinct. These experiments, and others using isolated plants and flowers, also show the pronounced place-memory which bees possess, despite which, however, their radius of action is usually short (about a mile from the hive).

Attraction for considerable distances may evidently be effected by strongly scented flowers, but our ignorance respecting such phenomena as the "assembling" of moths sufficiently indicates how much is still to be learnt regarding long-distance perception of stimuli. An increased number of visitors was noted by Clements and Long to flowers from which all the conspicuous parts had been removed, a result which was attributed to the greater accessibility of the nectar. In this connexion, one may recall that quite inconspicuous flowers with little or no scent but containing honey are freely visited. The odour of honey itself has been suggested as the effective agent of attraction in these cases, but the addition of honey to artificial flowers has little effect in increasing the number of visitors to them. On *a priori* grounds it would seem not unlikely that the range of light and scent perception in bees should be different from our own, but there appears to be little experimental evidence to support such a view. Various attempts have been made with mutilated insects to determine the seat of sense perception, but with regard to most of these, whatever view may be held as to the humanity of their conception, there can be little doubt as to their lack of scientific value.

There are but few observations and still fewer experiments which give any indication as to the importance of competition between flowers for the visits of insects. Robertson (1914) held that the flora is the limiting factor to the size of the bee population, whereas Lovell (1914) held that bees only collect a portion of the available pollen and nectar. The latter is probably the more correct view, and cases have been recorded

from gardens of species which are normally visited being entirely neglected for more attractive types. Upon the acuteness of this competition depends the importance to be attached to the sequence of flowering periods. Clements and Long, using the method of reciprocal bouquets, came to the conclusion that habit was the most important factor in determining preference, but that abundance of nectar or ease of access might overcome the effect of custom.

The marked capacity for memorisation by bees which training experiments reveal show that features of floral construction, of an apparently trivial character, may be of real importance in facilitating recognition. Moreover, the readiness with which bees discriminate the most profitable and easily worked flowers gives added significance to the minutiæ of floral architecture.

Further progress in the study of insect behaviour in relation to flowers would appear to demand the use of marked individuals of freshly hatched insects which have not acquired the habits that so largely determine their actions when adult.

X-ray Studies on the Crystal Structure of Iron and Steel.

At the recent meeting of the Iron and Steel Institute Messrs. A. Westgren and G. Phragmen presented a continuation of work published by them two years ago at the same Institute. The present paper deals with the crystal structure of δ iron, the crystal shape of Cementite, and the structure of Austenite. In their previous paper a series of powder photograms of α, β, γ and δ forms of iron was reproduced. At that time all attempts to get a photogram of δ iron (stable only above 1400° C.) in the pure state had failed. Its interference lines were mingled with those originating from γ iron. By improved heating arrangements it has been possible to obtain a more uniform temperature, and the new photograms are quite free from γ interferences and confirm the conclusion previously drawn, namely, that δ iron has the same lattice structure as α and β iron.

The question as to how the atoms are grouped in Cementite (Fe_3C) has even now not been solved. The powder photogram contains a very large number of lines, some of which flow into one another. As many of the interferences of this orthorhombic substance practically coincide it could not be settled definitely, without a more thorough experimental investigation, to which of the net planes the lines of the powder photogram correspond. To decide this question so-called "complete photograms" or "rotation photograms" have been taken of a Cementite crystal obtained from the blow-hole of a spiegel melt. The only developed faces (001) were finely striated parallel to [010]. The precision camera designed for this purpose was described by the authors in NATURE of January 26, p. 122. The theory of the photograms obtained has been given by Schiebold and Polanyi. A special camera was constructed for establishing the lattice dimensions and the authors showed photograms thus obtained. The edges of the elementary parallelepiped are 4·518Å, 5·069Å, and 6·736Å. This corresponds with an axial ratio of 0·671 : 0·753 : 1. Laue photograms taken parallel with the three axes have given an axial ratio in perfect accordance with the above. If it is assumed that the elementary parallelepiped contains four molecules of Fe_3C the density of Cementite must be 7·68. Values hitherto available range from 7·74 obtained by Benedicks to 7·59 by Levin and Dornhecker.

The discrepancy which has hitherto existed with regard to the crystal structure of Cohenite—the iron carbide present in meteorites—has been cleared up. Weinschenk, who first investigated this mineral, found that its composition corresponds to Fe_3C, but concluded that it probably belonged to the regular system. Goniometric measurements were afterwards carried out by Hussak on a Cohenite crystal obtained from a Brazilian meteorite. In spite of the small size of the crystal, the fact that its faces were frequently curved, and that most of them gave very poor reflections, Hussak concluded that Cohenite belonged to the regular holohedral system. Even so, some of his angles differed 2° or more from the values characteristic of the cubic crystal. The authors show powder photograms of cementite and Cohenite which are practically identical. These two substances are therefore orthorhombic.

The authors have also used their precision camera to investigate the structure of Austenites obtained in various ways, both pure and intermixed with Martensite. They conclude that carbon dissolved in γ iron has an enlarging influence on the lattice dimensions, and that the lattice parameter changes from 3·606Å in the case of Austenite containing 0·9 per cent. of carbon, to 3·629Å in the case of the saturated solution containing 1·7 per cent. The Martensite lines, however, are too cloudy and broad to enable conclusions to be drawn concerning the lattice dimensions of the α iron in quenched steels. The authors reason that if carbon atoms replace iron atoms in the γ iron lattice the dimensions should decrease with rising carbon content, since the carbon atoms are much smaller than those of iron. Since, however, the opposite is the case, it seems probable that Austenite is not formed by simple substitution, but represents an addition product with the carbon atoms in the interstices between the metal atoms.

Precision photograms of a manganese Austenitic steel, having a lattice parameter of 3·624Å, show that in all probability this is the case. The density of the steel can be calculated either on the assumption that the iron and carbon atoms replace each other in one and the same lattice, or that the mass of the carbon atoms is uniformly distributed among the metal atoms which occupy the points of the face-centred cubic lattice. In the former case the density is 7·36, in the latter 7·83. The experimental value found was 7·83. The second assumption therefore is correct, and this Austenite is not formed by simple substitution but is an addition product. The real nature of the addition of carbon atoms cannot be decided on the basis of the results so far obtained. The authors suggest that it may be a substitution of the atoms of the γ iron lattice by complexes consisting of an iron atom combined with one or more carbon atoms.

H. C. H. C.

Obituary.

SIR JETHRO TEALL, F.R.S.

BY the death on July 2 of Jethro Justinian Harris Teall, one of the most noted and revered of living geologists has been lost to science. Accomplished in all branches of geology, he gained a world-wide reputation more especially as a pioneer in petrography, at a time when the study of igneous and metamorphic rocks was as yet in its infancy. Born on January 5, 1849, he was the son of Jethro Teall by his marriage with Mary, daughter of Justinian Hathaway, of Gloucestershire. On leaving school he went to St. John's College, Cambridge, and by so doing contributed to the development of the noted school of geology which was then coming into existence under Bonney's auspices. He was bracketed second in the first class of the Natural Science Tripos in 1872, and in 1874 was awarded the Sedgwick Prize for his researches on the Lower Greensand. He held a fellowship at his college from 1875 until 1879.

For a few years after taking his degree, Teall was engaged in delivering University Extension lectures, but his tastes lay rather in the direction of original research, more especially as regards the composition and origin of igneous rocks and the phenomena of metamorphism. In such studies British geologists had been outpaced by continental workers, but the balance was restored by the publication of Teall's "British Petrography," a book which was not only far in advance of its time, but was also a classic, and still remains a standard work of reference on the subject with which it deals. In the preface he alludes briefly to circumstances which threatened a tragic termination. "The work was commenced in February 1866, and completed in March 1888. One hundred and sixty-four pages and twenty plates were issued to subscribers in monthly parts. The issue then ceased, owing to the failure of the publishers, and I was compelled to take the work into my own hands in order to finish it." A discussion which took place between Teall and some of his friends in the Geological Survey, when the fate of the book lay in doubt, remains fresh in my memory. It was distasteful to press the author to dip so deeply into his own pocket as would be necessary to complete the publication, yet it was impossible to contemplate the abandoning of a work of such outstanding importance. In the end he faced the risk of loss, and I have reason to believe was eventually recouped by the sales what he had expended on publication. He had intended to include detailed petrographic descriptions of the sedimentary rocks and crystalline schists, but though some plates were included, he was unable to find space for the letterpress. Both kinds of rocks have since received much attention, but it is a matter for regret that they were not dealt with by the same master hand.

At this time it had become apparent that the wholetime services of a petrographer were required for the Geological Survey. Assistance in the identification of igneous rocks in the field required by the surveyors, and the technical descriptions of such rocks in the Memoirs, called for the services of an expert petrographer. At the same time, the care of the petrographical laboratory and the custody of the specimens collected in illustration of the field work, pointed to the necessity of that petrographer possessing businesslike habits. Sir Archibald Geikie, Director-General at the time, selected Teall for the post, as now standing in the first rank of British petrographers. The appointment was made on June 20, 1888, to the lasting benefit of the service. Though the nature of his duties necessitated attendance at the office for a large part of the year, the petrographer was able himself to take a small share in the surveying. Thus Teall was responsible for the mapping of the northern part of Raasay, an area occupied by schists and intrusive igneous rocks.

In 1901, on the retirement of Sir Archibald Geikie, Teall was appointed Director of the Geological Survey and of the Museum of Practical Geology. The institution had recently come under the consideration of a strong committee, the appointment of which had been strongly pressed for by the staff. The committee included representatives of various Government Departments and of scientific and mining interests. The recommendations made were sound and practical, and the task of giving them effect could not have been entrusted to more capable hands than those of the new Director. While the public service benefited, the time available for his own research work was unfortunately curtailed. But for his heavy administrative duties, we may suppose that "British Petrography" might have been completed on the lines originally contemplated. In 1914 Teall retired, leaving the institution as regards its work, organisation, and remuneration in a stronger position than it had ever before held. In 1901–5 he served as a member of the Royal Commission on Coal Supplies, representing geological interests with Mr. Lapworth as his colleague, until the latter resigned on account of ill health. He received a somewhat belated honour of knighthood in 1916.

Teall received honorary degrees from the Universities of Oxford, Dublin, and St. Andrews. He was elected a fellow of the Royal Society in 1890 and twice served on the Council, once as vice-president. In 1893 he was president of Section C (Geology) of the British Association, and in 1900–2 was president of the Geological Society of London. From that Society he received the Bigsby Medal in 1889, and its highest honour, the Wollaston Medal, in 1905. In 1907 he was awarded the Delesse Prize by the Paris Academy of Sciences. In presenting the Wollaston Medal, the president (Dr. Marr) addressed Teall in words which all who knew him will endorse. "You have ever placed your great store of knowledge at the disposal of other workers. How much work was thus due to you will never be known . . . but was it known, I can safely aver that it would be found to have promoted researches concerning the mineral structures of the Earth, to so great an extent as to render you doubly deserving of this medal."

A. STRAHAN.

SIR HARRY JAMES VEITCH.

FOR several decades past there has been no such outstanding figure in the horticultural world as Sir Harry Veitch, whose death on July 6, in his eighty-fifth year, we regret to record. His chief ability was his highly developed business faculty, for he could

lay no claim to scientific distinction, probably not even to a taste for science. Nevertheless, during a long and honourable career, he did more than any one to enrich our gardens with beautiful plants from foreign countries, and in that way helped on the cause of botanical science very considerably. Whilst his primary interest was to introduce to Great Britain plants valuable from the trader's point of view, he never grudged the time his collectors spent in making pure botanical collections of dried material. The collections made by his brother, John Gould Veitch, in Japan, consisting largely of cones of pines, firs, spruces, etc., helped greatly towards the elucidation of the coniferous flora of that country, just as, thirty years later, did the collections made by Wilson that of central and western China.

Sir Harry had that supreme endowment of the business man—the faculty of finding capable assistants —and in the long roll of collectors who worked for the firm, from William Lobb in 1840 to E. H. Wilson in 1900, there are included many famous names. Scarcely less noteworthy were the activities initiated by him in the hybridisation of plants. Under his direction, the first hybrid orchid was raised, *Calanthe Dominii*, the forerunner of a branch of horticulture that has grown to enormous dimensions at the present time. Very valuable work, too, was done in the improvement of hippeastrums, the East Indian group of rhododendrons, as well as in fruits and vegetables.

Sir Harry played a great part in the International Horticultural Exhibition of 1912, and his work for it was acknowledged by the bestowal of a knighthood on him. It is interesting to recall also that he was the last survivor of the managing committee of the previous International Exhibition of 1866. His career may be safely described as unique in horticulture in its length and activity. Two valuable standard works, the "Manual of Coniferæ" and the "Manual of Orchidaceous Plants," were published under his auspices, although the actual work was done by his assistant, A. W. Kent.

About ten years ago he retired from business and, having no one to succeed him, the Chelsea firm of Veitch came to an end, an event which can only be regarded as a calamity to British horticulture, for never had it stood higher in public estimation than during the days when gardeners, both amateur and professional, watched in sadness its famous collections of trees, shrubs, and hothouse plants being dispersed under the hammer. For the rest of his life, until within a few months of his death, Sir Harry worked actively in the interests of the Royal Horticultural Society, the astonishing success of which owes much to him, and in helping the many charities in which he was interested.

WE regret to announce the following deaths:

Dr. R. Kidston, F.R.S., the distinguished palæobotanist, on July 13.

Prof. A. Marshall, emeritus professor of political economy, University of Cambridge, on July 13, aged eighty-one.

Sir Sydney Russell-Wells, member of Parliament for the University of London and vice-chancellor of the University 1919–22, on July 14, aged fifty-four.

Mr. Dean C. Worcester, first secretary of the Interior, Philippine Islands, who was largely responsible for the establishment of the Bureau of Science, the Philippine General Hospital and the College of Medicine in the islands, formerly assistant professor of zoology and curator of the museum at the University of Michigan, on May 2, aged fifty-seven.

Current Topics and Events.

REPRESENTATIVES of a number of educational, scientific, and commercial bodies in Great Britain and Overseas attended a conference organised by the Decimal Association at the Institution of Electrical Engineers on July 9. The main subjects discussed were the Association's proposal to divide the shilling into ten pence instead of twelve, and to alter the Imperial gallon so as to make it equal to four litres. The former proposal means a twenty per cent. increase of the value of a penny, and by it "an almost complete decimal coinage would be secured, while preserving the old names of *l. s. d.* and the three-column method of book-keeping, and incidentally a reasonable solution of the present impasse in penny postage and penny fares would be found." At present, services and commodities which could be profitably provided for slightly more than a penny are subjected to a fifty per cent. increase, whereas a penny would be sufficient if the value were increased as suggested. Mr. Harold Cox, who was a member of the Royal Commission on Decimal Coinage in 1920, said at the conference that if this proposal had been before the Commission he believed the majority of the members would have been in favour of it. The proposal to make the Imperial gallon equal to four litres instead of the present 4·54, so that the quart would become one litre and the pint half a litre, arises largely from the present confusion in the use of the designation "gallon" in commercial transactions relating to motor spirit and lubricating oils. The American gallon has a capacity twenty per cent. less than the Imperial gallon, and in South America a capacity of four litres is being called a gallon, so that a single name is being used for three different quantities. The introduction of a four-litre gallon would, of course, be an important step towards the adoption of other metric weights and measures in Great Britain. Whatever may be said in favour of the British system, it can never become an international system, and as trade develops with new countries the need for the use of a universal language of quantity by British firms must become more important every year. The conference passed resolutions urging the Government to appoint a committee to examine and report upon the proposals discussed.

IN connexion with a recent paragraph concerning the therapeutic action of chlorine gas, it is of interest to observe an account in the *Sunday Express* of July 6 of the introduction as an antiseptic of a compound containing chlorine. There are two ways in which chlorine can be used therapeutically; in one method, a very dilute mixture of the gas in air is

inhaled; in this case the effect is confined to the respiratory tract; in the other method a solution containing chlorine in very dilute solution is applied directly to the injured area as an antiseptic. It is not usual to utilise a solution of the gas itself, but some compound which is readily split up giving rise to an evolution of chlorine. Solutions of hypochlorous acid and hypochlorites were thus used during the War in the method of continuous irrigation of wounds. The new substance referred to in the *Sunday Express* by Callimachi is trichlorophenylmethyliodosalicylic acid. It will be observed that the basis of the compound is salicylic acid, which has itself antiseptic properties, but is more frequently in use as an antipyretic. Combined with the chlorine group, it is probable that a compound actively germicidal may be obtained; the chlorine dissociated from it will stimulate the tissues to pour out white blood cells and lymph to destroy the bacteria, while at the same time the salicylic acid radicle itself will attack the latter directly. It may be remarked that the other radicles combined with the salicylic acid will probably enhance the antiseptic value of the compound.

A reception was given at one of the conference halls of the British Empire Exhibition, Wembley, on July 8, by the Italian delegation to the World Power Conference, at which some films and slides were shown and interesting particulars were given of Italian power plants. Ing. G. Semenza introduced Sen. Prince Ginori Conti, who gave an illustrated lecture on the production of power from natural steam, which, after a certain amount of experimenting, is now used on a practical scale in various parts of the country. The steam issues from natural fissures, or bored wells, at pressures not exceeding 3 to 5 atmospheres, at temperatures up to 150° C. On account of this low pressure and the difficulty in condensing, owing to the presence of various gases mixed with it, the natural steam is not employed direct in the engines, but is used to heat special boilers to produce pure steam at a higher pressure. The largest plant of this kind, at Lardarello, contains three turbo-alternators, each of 4000 H.P. Ing. Emirico Vismara then showed some films illustrating hydro-electric power development in Italy, which started in 1892 with the famous Tivoli-Rome transmission, and in connexion with which plants will shortly be complete aggregating about a million kilowatts. Very high heads are available in the mountainous districts. The Moncenisio plant, for example, works under a head of 4200 ft., and among the extensive schemes projected in the Trentino is one for utilising a head of 6150 ft. Illustrations were given of the combination of irrigation schemes with electric power development and the manufacture of cyanamide artificial manures by the electric furnace. The linking up of the many water-power stations into one vast national power network is in active progress. This will involve a connexion to Sicily across the Straits of Messina, for which the relative merits of a submarine power cable, a tunnel, and an aerial line are being investigated. The last mentioned would require the construction of two towers, each a thousand feet high and two miles apart, to allow for a sag of 900 ft. The films shown included some very beautiful examples of Italian scenery.

In the year 1876 Lord Kelvin, then Sir William Thomson, took an active interest in the formation of the Loan Collection of Scientific Apparatus exhibited in the Western Galleries of the Science Museum, then part of the South Kensington Museum. He was a vice-president of the section "Physics," and at the Science Conferences held in the Western Galleries in May 1876 read two papers: "The Principles of Compass Correction" and "Electrical Measurement." Many of the original instruments of his invention which were lent by him for inclusion in the Loan Collection were allowed to remain permanently on exhibition in the Museum as gifts or loans, of great interest in the history of science. Since last autumn, when the Western Galleries were cleared to make room for the Imperial War Museum, most of these valuable objects have been stored away with 80 per cent. of the science collections previously exhibited in the Western Galleries. By utilising the main gangway of the unfinished gallery of the new Science Museum building in which, since last November, the remaining 20 per cent. of the collections have been exhibited, it has been possible to bring together these original Kelvin instruments so as to form a temporary exhibition of considerable interest in connexion with the Kelvin centenary. The following objects are included: Marine galvanometer used in the Atlantic cable expedition of 1858; iron-clad marine galvanometer used on board the *Great Eastern* in the Atlantic cable expedition of 1866; double curb transmitter; syphon recorder; various types of electrometer; original models of the tide-predicting machine; harmonic analyser for tidal computation; navigational sounding machine; binnacles; mariner's compasses.

A temporary exhibition of geophysical apparatus, etc., has been placed in the new building of the Science Museum, South Kensington, in the southern half of an unfinished gallery, the contents of which have been entirely rearranged. By arrangement between the Board of Education and the Royal Society Committee organising the Exhibition of Pure Science at the British Empire Exhibition, Wembley, it was intended that this exhibition should be placed in one of the new galleries of the Science Museum, but delayed progress towards the completion of these galleries has made it necessary to arrange the collection as above. It consists chiefly of objects selected from the permanent collections of the museum. To these have been added certain objects which, owing to the limited space available in the British Government Pavilion of the British Empire Exhibition at Wembley, cannot be shown there during the whole period of that Exhibition. The collection serves to give some idea of the history of the different sciences (meteorology, seismology, gravity, terrestrial magnetism, atmospheric electricity, geodesy) included under the general heading of geophysics, and to illustrate recent British contributions to these sciences.

Arrangements have been made to establish at Oxford in October next the Imperial Forestry

Institute, which is intended to serve as an educational and research centre for the British Empire. It will be a University institution, with the professor of forestry as its director; but it will be under the control of a Board of Governors, with a Forestry Commissioner as chairman. The educational work of the Institute will comprise (1) post-graduate training of forest service probationers and other qualified persons, (2) training of research officers in special subjects, and (3) provision of courses for selected officers already serving. The Institute will be open to various categories of students, who must as a rule have had previous training at a university in forestry or some allied science. The normal course of study will extend over one academic year, and the subjects dealt with will cover the whole range of forestry. The main cost of the Institute will fall in the first instance on the Forestry Commission and the Colonial Governments; but it is hoped that the Dominion Governments and India will give some financial assistance. Temporary accommodation has been arranged; but larger buildings will be necessary, and the formidable task of obtaining funds for the purchase of a site and the building of the Institute remains.

Sudden changes of temperature were characteristic of the weather conditions which prevailed in England at the close of the second week of July. An anticyclone to the south-east of the British Islands had asserted itself and was temporarily controlling the prevailing weather. With a south and south-east wind blowing from the heated continent of Europe, high summer temperatures were experienced on Saturday, July 12, the thermometer in the shade registering 87° F. at Kensington Palace, the recording station of the Meteorological Office for London, a similar reading being registered at South Farnborough and Hunstanton, while at Nairn, in the north of Scotland, the temperature was 80°. This is the highest temperature as yet this year, although it is not uncommon for summer temperatures of 90° and above to occur occasionally in London; during the heat wave and thunderstorm in July last year the thermometer on July 11 and 13 registered 92° at Greenwich, and at the corresponding time in 1921 the shade reading was 94°, while in 1900, 1911, 1912, and 1914 the thermometer rose to 90° and above in July. The highest shade temperature on record at Greenwich is 100° on August 9, 1911. Owing to the spreading in of a cooler current of air from the Atlantic, which caused a temporary displacement of the anticyclone, there was a brisk fall of temperature on Sunday, the transition occasioning thunderstorms and heavy rains in places. The anticyclone surged to the north-westward again on Monday, July 14, and there was a return of the bright and hot weather.

A memorandum forecasting the probable amount of monsoon rainfall in 1924 was submitted in the early part of June to the Government of India by Sir Gilbert T. Walker, the Director-General of Observatories. The monsoon rainfall of India is affected by previous conditions over various parts of the earth. Snow in the mountain region north-west of India is an important feature; the accumulations at the end of May were markedly about normal from Afghanistan to Almora, especially at the higher elevations, and this excess of snow may be expected to retard appreciably the development of the monsoon. Among other factors are the rainfall percentages over Java; these were in defect during the period October to February, which indicates abundant monsoon rainfall in India. For the Peninsula, the indications from S. America, the Cape, Java, S. Rhodesia, Zanzibar, and the Aleutian Islands are this year all favourable. For north-west India most considerations are favourable. Summarising the effects, it is forecasted that there will probably be some delay in the establishment of the Arabian Sea monsoon, particularly in north-west India. In the rainfall of the Peninsula an excess may be expected. The indications for north-west India are said to be conflicting, but in spite of heavy snowfall the rains there are likely to be normal or in excess.

Dr. R. F. Ruttan, director of the Department of Chemistry, McGill University, has been appointed Dean of the Faculty of Graduate Studies and Research to succeed Dr. F. D. Adams, who has resigned from the University. Dr. Ruttan was president of the Royal Society of Canada in 1919 and of the British Society of Chemical Industry in 1922. He was appointed an original member of the Honorary Advisory Council for Scientific and Industrial Research for Canada in 1916. He represented the Dominion at Brussels in 1919 on the International Research Council and was a member of the committee which framed the constitution and statutes of the International Union of Pure and Applied Chemistry. Dr. Ruttan is an active and successful investigator, a good organiser, and has developed a very strong graduate school in chemistry at McGill. He is regarded as an excellent choice for the head of the Graduate Faculty.

W. C. Allee refers in *Science* (vol. 59, p. 521, 1924) to his recent two months' visit to Barro Colorado Island, the site of the new station for tropical research in Gatun Lake, Panama Canal Zone. The island was the largest of the old hills rising above the valley of the Chagres River and consequently is now the largest of the islands in the man-made Gatun Lake. Comfortable living quarters have just been erected and equipped so that a small party can live and work with comfort in the jungle, which is of the rain forest type and spreads over the five square miles of the island. Ants and termites are common and offer excellent opportunities for the study of habits and for the collecting of commensals; several new species of the latter have already been found. Peripatus occurs on the island. Birds, lizards, armadillos, peccaries, racoons, night monkeys, white-faced monkeys and black howling monkeys are common and relatively tame, and among other mammals found either on the island or near by are tapirs, sloths and ant-eaters. The station affords an opportunity for the study of the physical conditions under which animals live in this sort of jungle and has the great advantage of ready accessibility—being only two hours' journey from Panama City.

SIR WILLIAM POPE has been elected a foreign member of the Reale Accademia Nazionale dei Lincei of Rome, in the Section of Physics and Chemistry and their Applications.

THE autumn meeting of the Iron and Steel Institute will be held at the British Empire Exhibition, Wembley, on September 4-5. Applications to attend the meeting must be received at the Institute not later than August 15.

WE learn from *Science* that William Gaertner, president of the Gaertner Scientific Corporation, Chicago, has been awarded the Howard N. Potts Gold Medal by the Franklin Institute, "in consideration of his notable achievement as a designer and maker of scientific instruments, materially contributing to the success of the research in physical science."

APPLICATIONS are invited for an inspectorship of agriculture under the Sudan Government. Candidates for the post must have had a thorough practical and scientific training in agriculture and possess the national diploma or a university degree in agriculture. Particulars of the appointment are to be had from the Inspecting Engineer, Egyptian and Sudan Governments, Queen Anne's Chambers, Westminster, S.W.1.

THE Department of Scientific and Industrial Research invites applications for the post of superintendent of its chemical research laboratory. Candidates should have special knowledge of some branch of pure or applied chemistry. Particulars of the duties attaching to the post and a form of application can be obtained from the Secretary, Department of Scientific and Industrial Research, 16 Old Queen Street, S.W.1. Applications must reach the department not later than September 30.

THE International Commission on Illumination will hold its sixth session at Geneva from July 21-July 25. The session meets under the presidency of Dr. E. P. Hyde. Twenty-six papers on subjects connected with illumination are being presented, and delegates from America, France, Great Britain, Italy, Japan, Poland, and Switzerland will be present. The papers deal with photometric nomenclature, primary standards of light, heterochromatic photometry, automobile and industrial lighting, and legislation. It is expected that, as a result of the discussions, progress will be made on several problems in which international agreement and co-operation is desirable.

THE annual meeting of the British Medical Association opens with the meeting of the Representative Body on July 18, and on the evening of Tuesday, July 22, Mr. Basil Hall will deliver his presidential address at the Regent Picture House, Manningham Lane. Among the eminent foreign guests who will be present are Dr. Alexis Carrel of New York, Prof. Ignacio Barraquer of Barcelona, and Dr. Van den Bergh of Leyden. Before this address, the president will present the Stewart Prize to Prof. E. Mellanby, of the University of Sheffield, for his important discoveries on the relation between rickets and dietetic deficiency, and the Gold Medal of Merit of the Association (the highest award in the bestowal of the Association) to Dr. H. B. Brackenbury for his arduous and distinguished services to the Association and the medical profession.

THE summer conversazione of the Natural History Museum Staff Association was held on July 2, and was attended by a large number of members and visitors, many of the latter coming from overseas. The remarkable series of specimens which had been arranged by the desire of Dr. W. Bateson, a Trustee of the Museum, to illustrate the variation in characters in three zoological groups—birds, mammals, and molluscs—attracted much attention. Considerable interest was also taken in the selection exhibited from the collection mainly of vertebrate fossils made by the late Mr. R. W. Hooley in the Wealden of the Isle of Wight. This extensive collection has recently been acquired by the Trustees. Other notable exhibits included a new plant genus belonging to the family of Umbelliferæ and collected by the Misses Godman in Central Africa; and a few examples of the splendid photographs taken by Mr. M. Maxwell of the elephant and the rhinoceros.

THE Lecture Bureau of the Selborne Society has already issued its list of lectures for the 1924-25 season. The names of more than fifty lecturers appear in the list; the subjects offered number considerably more than three hundred, and thus afford a very wide field for selection by those desirous of engaging lecturers during the forthcoming season. The Bureau caters for all tastes: literature, art, scenery, folk-lore, commerce, psychology, and many of the branches of natural science are well represented on their list. We note, however, that while physical and biological subjects are named fairly frequently, there is an absence of those concerned with chemical processes. Considering how largely these enter into the industrial life of the present day, we venture to suggest that there are, up and down England, numerous audiences eager for clear information on such topics. Inquiries concerning these lectures should be addressed to the Secretary, Selborne Society, The Hermitage, Hanwell, W.7.

THE Rockefeller Foundation has issued a review of its activities during 1923, compiled by the president, Mr. George E. Vincent. A sum of more than eight million dollars was expended in forwarding public health and medical education in all parts of the world. The work included the support of 636 fellowships, international visits, emergency relief to institutions of 15 European countries, contributions to schools of hygiene, hookworm campaign in conjunction with 20 governments of the world, yellow fever campaign in Brazil, contributions for medical education in Great Britain and other countries, and malaria control in several countries.

IN a lecture given by Mr. T. Thorne Baker at the Royal Society of Arts on "Photography in Science, Industry, and Medicine" (R.S.A. Journal, June 23), which was illustrated by a very large number of examples, the lecturer said that "the plate chemist has learned the secret of the sensitiveness to light of

silver bromide, he can produce an emulsion in gelatin of this unique substance, which shall have a predetermined size of grain, of contrast-giving power and rapidity. He can make it sensitive to all the colours of the spectrum, to the invisible infra-red and ultra-violet rays, to the X-rays and shortest wave motions produced by radium." Mr. Thorne Baker explains that the sudden disappearance of pictures transmitted by telegraph was because the cost of transmission proved to be "altogether prohibitive." He hopes that before long a new system will be available on a really commercial scale—the time of transmission being reduced to 2½ minutes.

WE have received No. 118 of Abderhalden's "Handbuch der biologischen Arbeitsmethoden" (Lieferung 118, Abt. 2, Physikalische Methoden, Heft 4. Die meteorologischen Messmethoden, von Walter Georgii; Die Makrophotographie, von Marie Kundt; Farbenphotographie, von Walter Thiem. Pp. 483-618. Berlin und Wien: Urban und Schwarzenberg, 1924. 6·40 Schw. frs.). It deals with meteorological measurements, such as temperature, pressure, moisture, wind-strength, etc.; macro-photography and colour photography. The matter is strictly practical, and not overburdened with a variety of methods or formulæ. In the photographic section, the support and manipulation of the camera and the support of subjects of various kinds are dealt with at length, as well as the numbering of series, as for indexing purposes, the copying of diagrams, engravings, and so on. The few pages on colour photography give just the extra assistance needed for the use of autochrome and "Agfa" colour plates by daylight and artificial light.

MR. F. S. SPIERS, secretary and editor to the Faraday Society and secretary to the Institute of Physics, has moved his office to 90 Great Russell Street, W.C.1 (Telephone, Museum 5718). The publishing office of the *Journal of Scientific Instruments* is now also at this address.

Our Astronomical Column.

THE LESSER MAGELLANIC CLOUD.—There have already been several estimates published of the distance of this object. Prof. Harlow Shapley (Harv. Coll. Obs., Circ. No. 255) revises these in the light of new photographic determinations of the magnitudes and periods of the numerous Cepheid variables in the Cloud. The results point very consistently to a distance of 31 kiloparsecs or 100,000 light-years. He notes that Dr. R. E. Wilson's researches on the proper motions of galactic Cepheids tend to make the estimated distances of clusters and the Magellanic Clouds smaller by 20 or 30 per cent.; but that this reduction may be cancelled if Kapteyn's suggestion of systematic errors in the accepted proper motions in declination should be correct. He proposes, therefore, to postpone any correction till the question is settled.

The diameter of the Cloud is 6500 light-years, and its depth in the line of sight is presumably of the same order, so that it is no inconsiderable universe in itself. Its brightest stars are estimated to be of absolute magnitude −7·0, and diameter 1000 million kilometres, thus exceeding Betelgeux and Antares in size. It has been found possible to ascertain the general spectral types of some of them: types K5 and M occur among these, and the largest diameters are to be expected in these types.

The Cloud is receding with a speed of 170 km./sec., equivalent to a kiloparsec in 6 million years; Prof. Shapley suggests that it may have been a galactic star cloud 200 million years ago.

DISTRIBUTION OF ENERGY IN STELLAR SPECTRA.—The spectral energy curves of stars of types F5, A, and B have been measured by M. J. Baillaud, *Comptes rendus* of the Paris Academy of Sciences, May 12, and are found to be distributed into three groups, one for each type. The curve of Procyon (F5, dwarf) is the only one of those measured which approximates throughout to the "black body" form; those for types B and A have no relation to a black body curve, whatever temperature is assumed, at any rate for wave-lengths shorter than 500 $m\mu$; it is thus impossible to use the curves for the determination of temperature. The author concludes that the origin of the observed continuous spectrum is not the same for the white stars as for the yellow; for the sun and dwarf stars like Procyon, the continuous spectrum apparently comes from a photosphere consisting of incandescent solid particles; for A and B stars the radiation seems to come from masses of gas at high temperatures; hydrogen and certain metallic vapours have been observed to emit continuous spectra, of a similar nature to those of these stars, in the laboratory. In certain cases, there appears to be a combination of the above sources of radiation; this may be due to the emission of black body radiation by a central nucleus, and of a high peaked continuous spectrum by surrounding gases.

SPIRAL STRUCTURE IN STAR CLUSTERS.—Attention is directed by Dr. P. ten Bruggencate, in the *Zeitschrift für Physik* for June, to the discovery of remains of spiral structure in the B stars of the star cluster Messier 13, by Freundlich and Heiskannen. Dr. Bruggencate has plotted the bright and the fainter stars separately, on millimeter paper, for Messier 3 and Messier 15; and finds that the 150 bright stars of the former cluster show distinct signs of a spiral structure, while 270 fainter stars indicate an elliptical arrangement, the direction of the major axis of the ellipse being estimated with considerable certainty. Apparently the line joining the two points on either side of the cluster from which the arms of the spiral proceed, coincides in direction with the major axis of the cluster, as is required by the theory of Jeans. For Messier 15 there is not much evidence of spiral structure; but the Bonn catalogue is not sufficiently complete for accurate investigation of this cluster. Messier 37, which is an open cluster, shows Shapley's phenomenon, *i.e.* the giant stars are brighter the redder their colour, which indicates that they have a common origin; the complete catalogue of this cluster by v. Zeipel and Lindgren was employed, and it was divided into four concentric rings, the principal axis of inertia for the B and A stars of each ring being determined by counting. The direction of this axis was found to be constantly twisted in the counter-clockwise direction in proceeding outwards, the total observed twist being a little more than 45°. Thus even in an open cluster remains of a spiral structure may be found when the larger stars belonging to it are examined, the smaller stars which originally had a similar structure having become irregularly scattered.

Research Items.

DISINTEGRATION IN PRIMITIVE SOCIETIES.—Capt. G. Pitt-Rivers, in his presidential address to the Section of Ethnology and Anthropology of the Australasian Association for the Advancement of Science in 1923, which has recently been issued in the Report of the Association, offers some interesting suggestions in reference to tests which might be applied in estimating the trend of development in any given community, referring in particular to the changes which are brought about in a primitive society when in contact with white civilisation. For this purpose a comparison of different cultures and their social and moral systems is not adequate; but a standard or norm is to be found in the tendency to integration or disintegration. Taking, for example, the Papuo-Melanesian and Micronesian cultures, the principal factors of social integration are: (1) the chieftainship; (2) magic and sorcery, (3) the system of exchange of gifts, partly economic, partly ceremonial and non-economic. In the case of each of these the effect of contact with white civilisation has been disintegrative. In Papua the institution of a village policeman as the chief district authority has undermined the position of the chief without ensuring that the substitute shall be of a type to take his place in the native's estimation; while by suppressing sorcery and magic the administration has destroyed the strongest influence which made for law and order.

FORAMINIFERA OF LORD HOWE ISLAND.—Messrs. E. Heron-Allen and A. Earland (Journ. Linn. Soc., Zool., vol. 35, 1924) describe a collection of Foraminifera, made by Prof. R. D. Laurie at Lord Howe Island, South Pacific, which contains 199 species and varieties. Two new genera are described—Craterites, which is related to Orbitolites, and Diffusilina, the neatly constructed test of which and the high proportion of cement in its finished exterior surface indicate affinities with the Lituolidæ, but it has no close relationship to any previously recorded type. The authors direct attention to the profuse occurrence of species in reproduction, both by viviparity—young examples being found in a cavity resulting from the absorption of the internal septa of the test—and by "budding" from the aperture. The material was from the reefless area of the island only, and the authors believe that many species would have been added to the list if a collection had also been made among the reefs and in the lagoon. The material shows that a large proportion of the specimens are not of local origin but are more or less water-worn and have travelled some distance. Many of the species recorded have a wide range, from East Africa through the Malay and Australian seas to the Pacific.

MEDICAL PROTOZOOLOGY.—In a recent lecture on medical zoology (*Amer. Naturalist*, vol. 58, pp. 1-23, 1924) Prof. R. W. Hegner surveyed the recent investigations on protozoa carried on in his department of the Johns Hopkins University He said that various theories had been put forward to account for relapses in malaria, and that one of these seemed now to be proved, for Dr. Ben-Harel had been able to show, by working on canaries infected with Proteosoma, that when parasites are apparently absent from the blood they exist in small numbers in the spleen and bone-marrow, where they undergo asexual reproduction in a normal manner He referred to the work of Dr. Taliaferro on *Trypanosoma lewisi* in rats, and stated that pure lines of this species had been obtained by inoculating clean rats with single trypanosomes, and an intensive study had been undertaken of the resistance which the rat offers against infection. There are three manifestations of such resistance: (1) the rate of reproduction of the parasites is retarded until it is inhibited altogether by about the tenth day; (2) a large number of parasites are destroyed between the 10th and 14th days; and (3) the rest of the trypanosomes—non-reproducing adults—are finally destroyed. The first resistance is due to the formation in the blood of the rat of a reaction product which inhibits reproduction of the trypanosomes but does not destroy their vitality; the second resistance is as yet not explicable, but the third—the destruction of the organisms—is brought about by the formation of a lysin. Suggestive observations are recorded on the effects of a change of diet on *Trichomonas muris* in the cæcum of the rat—for when heavily infected rats were put on a well-balanced carnivorous diet for a week, the number of Trichomonas decreased almost to disappearance, apparently owing to alterations in the bacterial content of the cæcum and in the products of their activity. Prof. Hegner suggests that a carnivorous diet might be an effective method of treatment of flagellate dysentery in man, and states that the method has been put into practice in a few cases with "remarkably rapid and satisfactory" effects.

ACIDOPHILUS MILK.—Artificially prepared soured milks have been made use of as articles of diet in various parts of the world from time immemorial, and years ago Metchnikoff introduced the use of milk soured with the Bulgarian bacillus as a preventive of the onset of old age! Recently Prof. L. F. Rettger, of Yale University, has found that the *Bacillus acidophilus* produces a soured milk of considerable value in the treatment of intestinal toxæmias (*Science*: Science Service Supp., June 13). Skimmed cow's milk is boiled and cooled and inoculated with the organism, which is allowed to grow for twenty-four hours At the end of this time the milk is curdled with a soft curd, and on shaking assumes the consistency of thin cream. Taken daily in quantities of from one to two pints, the fermentive and putrefactive bacteria in the intestines are much reduced in numbers with corresponding benefit in suitable cases.

TEMPERATURE IN THE NETHERLAND INDIES.—In Verh. No. 8, vol. 1, part 5, the Royal Magnetic and Meteorological Observatory of Batavia has recently published a discussion of temperature by Dr. C. Braak in continuation of other discussions on the climate of the Netherland Indies. A brief English summary is given as well as the full discussion in Dutch. Recent observations have been mostly used, as the older observations are generally untrustworthy, owing to defective exposure. Temperature is fairly uniform during the whole year, and in addition to the annual variation of winter and summer there is the influence of the monsoon. Whether the wind blows from south or north it brings air of equal temperature. Rain showers may cool the air temporarily, but generally uniformity of temperature is apparent. For daily differences in the dry season, the maximum temperatures are usually higher than in the wet season and the minimum lower, the daily range being greater in the dry season. The time of the maximum varies with the height above sea level, and the maximum occurs relatively early at the high mountain stations, where night frosts are occasionally noted in August and September. Diurnal variation of mean air temperature from observations in the Archipelago and in the adjacent Indian Ocean gives an extreme range of 0·87° C., while for the sea it is 0·75° C. The average air temperature is 26·05° C., the sea 27·10° C., the sea water being thus 1·05° C. warmer than the air. The decrease of temperature with increasing height in the free atmosphere is discussed, and the variation of soil temperature with depth Monthly series of isotherms of air and sea over the adjacent waters, and

copious tables and diagrams, are given in the original text. The discussion is of the highest value for the advancement of the world's meteorology, dealing with the temperature of the part discussed in the most complete and scientific manner.

THE SURFACE LAYERS OF OCEANIC WATERS.—After studying the records of the *Challenger* soundings and plotting the density and temperature against depth, M. J. Thoulet has found that there is a limited layer, near the surface of the oceans, in which the denser water, due to evaporation at the surface, sinks, and is mixed by wave action with lighter water, containing less salt, produced by the action of rain, the melting of ice and the inflow of rivers (*Comptus rendus* of the Paris Academy of Sciences, May 12). The mean thickness of this layer of mixture, or of rapid diffusion, varies in different parts of the ocean between 600 and 800 metres, being greater in the tropics than near the poles; a layer of minimum density divides it from the lower oceanic water, where there is only slow diffusion. The paper gives an account of the seasonal variations of this upper layer, which cause a movement of water towards the poles in summer, and a reverse movement in winter. The density in the minimum density layer varies from 1·0289 in hot regions to 1·0253 near the poles, with a mean value of about 1·0275. It is particularly regular in the South Atlantic and the Pacific, where it is rarely so high as 1·0280.

THE VACUUM TUBE DISCHARGE.—In the July issue of the *Philosophical Magazine*, Sir J. J. Thomson puts forward a theory of the electric discharge in gases at very low pressures such as are used in the older X-ray tubes, which is in better agreement with the experimental facts than the theory which depends mainly on the collisions between cathode rays or positive ions and the molecules of the residual gas for the source of ionisation. The process which takes place in the tube is rather as follows. The positive ions on striking the cathode emit radiation which, falling on the cathode, causes a photoelectric emission from the cathode. The electrons emitted acquire a high speed, and cause the molecules of the gas to emit a second radiation, which in turn ionises the molecules it encounters The recombination of the ions so produced constitutes the negative glow. On this theory, the difference of potential between a point in the dark space and the negative glow is proportional to the square of the distance of the point from the inner edge of the glow, which has been found to be the case by Dr. Aston.

ACTION OF A TRANSVERSE MAGNETIC FIELD ON THE CATHODE DARK SPACE —A communication from the Physikalisch-Technischen Reichsanstalt in the *Zeitschrift für Physik* for May, by Dr. A. Günther Schulze, describes an ingenious device for obtaining a self-adjusting, plane, horizontal cathode, which allows the magnet poles to be brought fairly close together, and at the same time enables the glow discharge to be produced at a distance from the glass walls, so that it is unaffected by them. A glass tube, diameter 4 cm and length 28 cm., is closed at one end, half filled with mercury, which forms the cathode, closed by a rubber stopper through which pass a glass tube connecting with the air pump and the connecting wires, and is laid horizontally between the magnet poles, so that the lines of force pass across parallel to the surface of the mercury cathode. The anode is near the stopper, and with a fairly high vacuum the glow discharge is deflected in a narrow band towards the sealed end of the tube. The width of the dark space, measured vertically, is obtained by means of a cathetometer; there is a minimum value for this distance d(*Fallraum*), which for all the gases investigated is near 0·70 mm.; for pressures of not less than 20 mm., d is very little greater than this minimum value with zero magnetic field, but for low pressures it is much larger, and can then be reduced to the minimum value when the field is increased sufficiently.

EXTRA HIGH FREQUENCY γ-RAYS FROM RADIUM —The secondary β-ray spectrum from lead, excited by the γ-rays of radium and its disintegration products, has been photographed and investigated by M. J. Thibaud (*Comptes rendus* of the Paris Academy of Sciences, May 19). Eight lines have been found, the energy in kilovolts of each being as follows:

1	2	3	4	5	6	7	8
152	203	258	330	516	593	671	1034.

All of these lines correspond with lines in the spectrum of radium and its disintegration products; 1, 2, and 3 are identical with lines found by Ellis to belong to radium-B, 4 has been observed by de Broglie and Cabrera in the spectrum of the same substance, 5 corresponds to a β-ray originating in the K level of radium-C, 6 to one from the L level of the same substance; the difference between the energies of these two lines is 77,000 kilovolts, which agrees with the number, 75,000 kilovolts, calculated from other lines of the radium-C spectrum for these two levels. According to Ellis's theory, these lines may be due to a nuclear γ-ray, with energy 605,000 volts; while line 8 of the lead secondary spectrum, which corresponds to a line from the K level of radium-C, is due to a γ-ray with energy 1,123,000 volts. Lead, which was used as the secondary radiator, is an isotope of radium-B, and the production of lines 1, 2, 3, and 4 in its spectrum is to be expected That the lines of radium-C are also obtained is regarded as due to the fact that the variation of the energies of the levels of radium-B and C is of the same order as the experimental errors.

SYNTHESIS OF METHANE FROM COAL GAS —Work on the synthesis of methane from coal gas has been carried out in the laboratories of the South Metropolitan Gas Company, and some results were described at the annual meeting of the Institution of Gas Engineers The preliminary complete purification of the gas from sulphur compounds necessary to avoid poisoning the catalyst involves the partial elimination of valuable unsaturated hydrocarbons from the gas, and the conversion of part of the carbon monoxide content of the gas to carbon dioxide. The loss resulting from these causes and the heat loss attributable to the exothermicity of the hydrogenation reaction would cause a considerable increase in the cost of the gas produced.

PHOTOGRAPHIC DEVELOPMENT AFTER FIXING.—Messrs. Lumière and Seyewetz have communicated to the Paris Academy of Sciences a method which places development after fixing upon a practical basis, which is recorded in the *British Journal of Photography* of June 27. Hitherto this process has required about ten times the usual exposure, presumably because the substance of the developable image, whatever it may be, is soluble in the "hypo" used for fixing By adding a little ammonia to the "hypo" and to the wash water, this drawback is overcome. The developer preferred contains sodium sulphite and paraphenylene-diamine in addition to silver nitrate, and yields negatives that recall those on collodion plates in appearance and other characteristics. The developer is exhausted in about an hour, and if more density is required it may then be replaced by a fresh portion, and thus continued up to 10 or 12 hours' duration. By this longer time the particles are about equal in size to those of the original silver bromide of the plate. Photomicrographs are given of the grain produced by development for 1, 3, 7, 24, and 48 hours. Even the coarsest grained plate gives a fine grained image unless development is unduly prolonged or the image is intensified.

The Kelvin Centenary.

IN the presence of a large and distinguished company, including delegates from the principal scientific societies of Great Britain, the British Dominions, Belgium, Denmark, France, Italy, Japan, Mexico, the Netherlands, Norway, Poland, Russia, Spain, Sweden, Switzerland, and the United States of America, Sir Charles Morgan (president of the Institution of Civil Engineers) handed the Kelvin medal to Prof. Elihu Thomson in the great hall of the Institution of Civil Engineers on Thursday, July 10.

In making the presentation, Sir Charles Morgan explained that the medal (Fig 1) was founded in 1914, principally by British and American engineers, to commemorate the advancement by Lord Kelvin of those branches of science which are especially applicable to engineering The award is dealt with by a committee of the presidents of the representative British engineering institutions, after their consideration of recommendations received from similar bodies in all parts of the world, and, in accordance with the terms of the trust, it is made to the person whom the committee finds to be the most worthy to receive this recognition of pre-eminence in the branches of engineering with which Lord Kelvin's scientific work and researches were identified. The only previous award of the medal was that made in 1920 to Dr. W. C. Unwin, whom he was glad to see present. He reminded his hearers that Prof. Elihu Thomson has been connected with the applications of electricity to lighting and power from the early days of the Thomson-Houston arc lighting system to the vast present-day activities of the General Electric Company of Schenectady. Prof. Thomson has made far-reaching discoveries relating to alternating and high-frequency currents and was a pioneer in electrical resistance welding A past president of the American Institute of Electrical Engineers, he has been the recipient of many high honours. In receiving the medal, Prof. Elihu Thomson said that he regarded the award as a compliment not only of a personal nature but also to the whole American electrical engineering profession. He liked to think of Lord Kelvin as the supreme example of what a man of engineering science could be.

Sir Richard Glazebrook then took the chair and directed attention to the great progress achieved during the hundred years that they were looking back upon. To this progress, no one had contributed more than the great man whose memory they were met to honour that day. The celebrations originated in a suggestion of Dr. Alexander Russell (president of the Institution of Electrical Engineers), but they were being taken part in by a long list of British institutions and by delegates from foreign societies, who had come from all parts of the world to do honour to Lord Kelvin's name. The chairman then received addresses in writing from a large number of foreign delegates who were present.

SIR JOSEPH THOMSON.

Sir Joseph Thomson then proceeded to deliver the Kelvin oration. In his opening remarks, he characterised Lord Kelvin as the Admirable Crichton of physical science. A great physicist, he was at the same time a great mathematician and a great engineer. He could make inventions as well as he could write text-books, and could take out patents as well as he could write papers. Few men had sprung to fame at such an early age. Born at Belfast, where his father was professor of mathematics, he commenced his studies at Glasgow at ten years of age, when his lifelong connexion with that city and university began. Before he was eleven he had won two prizes in mathematics, and before he was thirteen he had gained further distinction in this subject as well as in natural philosophy and logic. During these early years, his thoughts were turned to two subjects which were destined to play great parts in his subsequent career, the figure of the earth and Fourier's theorem. His later work with regard to the former produced one of his most important contributions to physics, and the latter formed the underlying basis of much of his other work. William Thomson, as he then was, went into residence at Peterhouse, Cambridge, in 1842, and was soon recognised as the most brilliant mathematician of his year, although he had to be content with the position of second wrangler in the mathematical tripos of 1845. He was, however, easily first in the examination for the Smith's Prize in the following year. After taking his degree, he worked for a few months in the laboratory of Regnault in Paris. This had a great influence on his career, not only in familiarising him with laboratory methods but also in introducing him to the work of Sadi Carnot, on which the second law of thermodynamics

FIG. 1 —The Kelvin Medal.

was afterwards based. In October 1846 he was appointed to the chair of natural philosophy at Glasgow, which he held with such brilliance for fifty-three years, soon extending the meagre facilities for experimental demonstration which he found there. Throughout his professorial career he may be said to have acted rather as an inspirer than as an instructor. He filled the ablest students with enthusiasm, the others with despair.

The decade of 1850–60 saw the establishment of the second law of thermodynamics, and Kelvin's work in this connexion has claim to be regarded as the most important of his many important contributions to physics Continuing this work, he published in 1851 a paper expounding the position of thermodynamics in a masterly way, introducing the idea of an absolute scale of temperature corresponding to the readings of the gas thermometer. He also found time to devote to thermo-electricity and magnetic and other problems. It is important to record that his paper on transient electric currents in 1853 revealed the discovery of the oscillatory nature of the discharge of a condenser in certain circumstances, which is the basis upon which the whole study of electrical oscillations and wireless telegraphy and telephony is founded. In further papers he dealt without intermission with discoveries of fundamental importance in nearly every branch of physics. An outstanding feature of his equipment for the attack of dynamical problems was his engineer's intuition of how matter in motion would behave. The secret of his success in applying mathematics to physical problems was that he knew what to expect. With his striking originality, he was greater in developing his own methods than in following the lead of previous workers. In this respect he might be described as a good radiator but a bad absorber. For sixty years he worked at the elucidation of the theory of the luminiferous ether, and no small proportion of his total of 661 papers is devoted to this subject. Although he had to admit failure as regards direct results, a good deal of benefit arose indirectly from these investigations. The lecturer referred briefly to the new outlook opened up in the teaching of dynamics, etc., by the publication of Thomson and Tait's work on natural philosophy, to Lord Kelvin's fascination by gyrostatic problems, and his theory of the age of the earth, which was afterwards invalidated by the discovery of radio-activity.

It was in 1855 that Kelvin first turned his attention to submarine telegraphy and took up the study of the propagation and retardation of currents in cables, and his first connexion with Atlantic cable enterprise was his election, in 1855, as a director of the Atlantic Telegraph Co. to represent the Scottish shareholders. He soon took a more active part and accompanied the original unsuccessful expedition on the *Agamemnon* in 1857, and the expedition in the following year, when only brief communication was established, as well as the final successful expedition of 1866. It is well known that the conversion of failure into success was in no small degree due to the ability and courage with which he faced the problems involved and to the instruments, including the marine galvanometer and the siphon recorder, which he devised. His instruments of another type revolutionised the practice of electrical measurement generally; and the formation of the British Association Committee of 1861 on electrical standards was mainly due to him. It was he who devised the first method of measuring resistance absolutely by the spinning coil

Kelvin was a keen yachtsman, and his interest in the sea led him to make most important contributions to navigation in his deep-sea sounding machine, tide predictor, and other apparatus. In addition to the direct results of his investigations, he produced great effect on scientific progress indirectly by the enthusiasm which he stimulated in others. This was very particularly seen at the meetings of Section A of the British Association, which his personality filled with life and interest. Kelvin was a man of outstanding vigour in the union of theory and practice and in untiring devotion to a great idea.

DR ALEXANDER RUSSELL.

An inspiring account of Kelvin's life and work was given by Dr. Alexander Russell in an oration delivered at the centenary commemoration at the University of Glasgow on June 25 and published in pamphlet form. Dr Russell, himself an old student of Glasgow who attended Kelvin's lectures, spoke of Kelvin's belief that the chief importance of science lay in its applications for the material benefit of the human race, and his unbounded enthusiasm in applying it to ameliorate our everyday life. He was impatient of the slow progress made in improving means of communication, systems of lighting, and methods of transport by land and sea. His vivid imagination saw the world as it might be if science, engineering, and human labour had no limitations.

Dr. Russell proceeded to outline Kelvin's early years at Belfast, his brilliant career as a student at Glasgow and Cambridge, and his subsequent greatness as a professor, and spoke of the importance of his original work in mathematical physics generally and particularly in thermodynamics, submarine telegraphy, terrestrial magnetism, and the oscillatory discharge of the Leyden jar, and his applications of the theories of gyrostatic action and vortex motion. Kelvin was also greatly interested in atmospheric electricity and his well-known navigational instruments include his deep-sea sounding machine, his tide predictors and analysers, and his famous magnetic mariner's compass. It is not so generally known that he was also a pioneer of the gyrostatic compass, of which he made a model in 1884. The wonderful series of electrical measuring instruments designed by Kelvin bears witness to his energy, his inventive skill, and his practical genius. His electrometers and electrostatic voltmeters are in use in every country of the world to-day. In 1878 he pointed out how simply electrical energy could be transmitted over great distances, and his law determining the size of mains has done much towards cheapening the cost of electrical distribution. Attention was also directed to the importance of his work on electrical units and standards. "For the number, variety, and importance of his great contributions to science," continued Dr. Russell, "he stands without a rival. His works are a gift to universal Humanity. Had it not been for Kelvin the world would have been perceptibly poorer to-day . . . And as the years roll on our debt to him grows ever greater."

OVERSEAS ELECTRICAL ENGINEERS.

A large party of representatives of overseas electrical engineering institutions who are visiting England, partly in connexion with the World Power Conference at Wembley, was entertained during the past week by the Institution of Electrical Engineers. The proceedings, which were to some extent combined with the Kelvin centenary celebrations, were inaugurated on Wednesday, July 9, at a reception at the Institution building on the Victoria Embankment, when the president, Dr. Alexander Russell, gave a brief address of welcome to the visitors. In the course of his address, he emphasised the truly international character of electrical science as evidenced by the names of our electrical units commemorating

great workers from many lands. It was particularly fitting that their visit coincided with the Kelvin centenary celebrations and the award of the Kelvin medal to Prof. Elihu Thomson, the successor of Lord Kelvin as chairman of the International Electrotechnical Commission. In another American representative they were glad to welcome Prof. Kennelly, of Harvard. Prof. Keith (secretary of the Engineering Institute of Canada) replied on behalf of the visitors, and in paying tribute to the work of Lord Kelvin referred to the part that he had played in the early days of the harnessing of Niagara. Representatives were present from the following societies: The American Institute of Electrical Engineers, Asociacion de Ingenieros de Caminos, Canales y Puertos (Madrid), Associazione Elettrotecnica Italiana, Dansk Ingenirforening, Norske Ingenirforening, Engineering Institute of Canada, Institute of Engineers (India), Institution of Engineers (Australia), Koninklijk Institut van Ingenieurs (Holland), Schweizerischer Electrotechnischer Verein, Société Belge des Électriciens, Société Française des Électriciens, South African Institute of Electrical Engineers, Svenska Teknologforeningen, Vereeniing van Directeuren van Electricitatabedrijvenin Nederland, and other bodies.

The reception was followed by a luncheon at the Hotel Cecil, at which some three hundred members and guests sat down. The toast of the visitors was proposed by Mr. Ll. B. Atkinson (past president), who included in his speech a few words of welcome in nearly every language of the visitors, and was responded to by Mr. J. W. Lieb (past president of the American Institute of Electrical Engineers). Most of the visitors attended at the presentation of the Kelvin medal to Prof. Elihu Thomson and the delivery of the Kelvin oration by Sir Joseph Thomson at the Institution of Civil Engineers in the afternoon. The full programme of entertainment of the visitors, as we have already announced, included the Kelvin banquet on Friday, July 11, and visits to Wembley, Cambridge, the Birmingham district, and Windsor, and a lunch on Tuesday by invitation of Lord Ashfield, chairman of the Underground Electric Railways of London, Ltd.

Electrical Progress and its Unsolved Problems.

THE above was the title of the James Forrest lecture delivered at the Institution of Civil Engineers on Tuesday, July 8, by Prof. Elihu Thomson. The lecturer recalled Col. Crompton's James Forrest lecture in 1905 entitled "Unsolved Problems in Electrical Engineering," and proposed to deal with similar matters from the present point of view, directing attention to the recent advances in various departments of electrical work.

Speaking first of the electrical phenomena in Nature, Prof. Thomson referred to terrestrial magnetism, and made the suggestion that the oxygen in the atmosphere, being magnetic in property, must in a measure influence the direction of the lines of dip within the atmospheric layer Of all natural electrical manifestations the thunderstorm is the source of most difficulty in electrical undertakings. The view of its cause now generally adopted is that of Simpson, making it a water-drop phenomenon. With the rapid passage of condensed drops through an uprising current of air, a fine spray is torn from them carrying a negative charge, and leaving the diminishing drops positively charged. The lecturer inclined to the view that the lightning flash is more of a steep wave-front discharge in one direction than a true oscillatory discharge. This, however, does not prevent structures capable of oscillation being activated by the shock of a heavy discharge There are still many unsolved problems connected with protection of electrical apparatus and lines from the effects of lightning, but with increased transmission voltages and their greater degree of insulation, lightning troubles may be expected to diminish. For the protection of buildings. however, there is ample security in the intelligent application of the principle of providing a best path to earth. The so-called "ribbon" discharges, or successive discharges down the same ionised air streak, stationary or travelling with the wind, are the most dangerous. With regard to the explanation of globular lightning, which undoubtedly exists, little progress has been made.

Magnetic storms and auroræ are now generally recognised to be connected in some way with sun-spot conditions. It would seem that from the spot areas, streams of electrified particles are projected at speeds possibly up to 2000 miles per sec. If the earth is moving in its orbit near such a stream a disturbance of the magnetic field is inevitable. When the earth is directly immersed in the stream, the outer thin envelope of gas entangles the electric particles, resulting in a decided elevation of charge or potential of the outer partially conducting layer. This charge may be carried around with the revolving earth, so that on the dark side a discharge takes place into the shadow of the earth, continuing until the received charge is exhausted, or there is no further entrance or absorption of ions on the side towards the sun. This would account for the fact that most short-lived auroræ begin in the evening, and for the induced effect on telegraph lines during the disturbance.

The old phenomenon of St. Elmo's fire has in late years a counterpart in the corona surrounding high-voltage lines, which, since it involves a loss of energy, should be avoided by increasing the wire diameter or otherwise, such as possibly by jacketing the line with hollow beads or shells. The same potential limitation exists in wireless antennæ, where corona discharge is apt to produce distortion as well as loss of energy.

Turning to questions of transmission of energy, Prof. Thomson said that in the broadest sense all transmission of energy is electrical in its nature, as all the properties of matter now seem to be fundamentally electric. He dealt briefly with the conditions of transmission lines, recalling that the flow of energy itself is not in the conducting wire but in the space surrounding it. In ordinary low-frequency currents little of the energy is radiated away into the space. At high frequencies the radiation loss is a measurable quantity, and at the highest frequencies, as used in wireless transmission, practically all the energy is radiated. In the past few years, the advances made in this form of electric transmission have given rise to a new art of unprecedented importance in the future. The lecturer dwelt upon some of the features of this advance, particularly in the development of the three-electrode thermionic valve, and mentioned interference of conditions of land surface, atmospherics, and "fading" as among the unsolved problems. He was inclined to think that the last-mentioned may be caused by displacement of phase relations by changes in the electrical condition of the lower atmosphere preceding distant lightning discharges.

Outside of high-frequency work, most of electrical engineering is based on the magnetic properties of iron, and although no great advance on the high figures of efficiency now attainable may be expected,

no definite limit can yet be set upon the reduction of iron losses by improved material. The recently discovered "Perm-Alloy," which magnetically saturates even in the earth's field alone, points the way to improvements in instruments, and raises questions as to the possible discovery of other alloys with equally surprising magnetic qualities. It is not to be expected that any real substitute for copper as a conductor can be found, although aluminium can sometimes be substituted for transmission lines, and its higher resistance is even an advantage in certain cases of rotors of induction motors In the matter of insulation, however, there will always remain room for further advances. The difficulties in the design of large generators are now mechanical rather than electrical.

Applications of electric transmission of power of another kind were mentioned in electric ship propulsion now applied to the largest battleships, to transmit power from the high-speed turbines to the low-speed propellers with advantages of efficiency and facility of control, and in other craft in connexion with Diesel and other oil engines as well as on land in Diesel locomotives, "petrol electric" automobiles, etc. The still unsolved problem of continuous or alternating current motors for railway traction was also dealt with, and other points in connexion with electric traction referred to included modern methods for suppressing flashing over at the commutators of rotary converters, and improved forms of control, including automatic control of sub-stations. In connexion with the beginnings of so-called "superpower" systems, an important problem is the control of power factor, and there is room for improved construction of static condensers for this purpose.

Passing on to the application of electricity for the production of heat, the lecturer indicated that it is more in localised heating for special purposes, or in the production of very high temperatures, that the field of electricity lies, than for the general warming of buildings. He dealt at some length with the possibilities of electric resistance welding of the "flash" and "spot" welding varieties, which is fast superseding riveting in a great variety of work. Arc welding has also considerable application. In electric furnace work a recent development is the Northrup high-frequency induction furnace in which iron cores are dispensed with and currents induced in the crucible at a frequency of the order of 10,000 cycles per sec. It is possible that currents of the necessary high frequency may be provided by valve or arc generators instead of special high-frequency alternators. The great advantage of electric heating in furnaces is the excellent control of temperatures and exclusion of gases. Electric heating can be carried out in vacuo, or, on the other hand, high pressures may be used with suitable furnace design.

Dealing with electric lighting, the lecturer traced the progress from the open carbon arc to modern magnetite and other arc lamps considerably used in America, and often in conjunction with mercury vapour rectifiers, and in the incandescent lamp, from the carbon filament lamp of forty years ago to the gas-filled tungsten lamp of to-day. It would seem, he said, that but little further advance in this field is to be expected. There is, however, much room for improvement in the application of the lighting units in illumination.

Reviewing the situation regarding storage batteries, Prof. Thomson expressed the view that the ideal has not yet been reached either in the lead battery or in the nickel-iron cell, both of which have serious disadvantages, especially for electric vehicle work. Even the latter, useful as it may be in certain circumstances, does not provide a true solution of the storage battery problem; "perhaps," he continued, "there is no solution possible."

There are many directions in which it is impossible to predict the developments of the future "Who is there," Prof. Thomson said, "to tell us of the momentous issues and events which may arise out of the studies in pure science, of atomic and molecular structure, and the energy relations involved, which have become in large measure the chief study in physical science of our day? Perhaps our comparatively feeble beginnings in thermionic emission and the manipulation, so to speak, of electric ions, infinitesimally small though they be, coupled with the knowledge of the electric structure of matter in all its forms, may be the foundation of a greater superscience of electricity of enormous importance to the future achievements."

University and Educational Intelligence.

ABERDEEN.—At the Summer Graduation on July 10 the honorary degree of LL D was conferred on Dr. Michael Comport Grabham. Dr. Grabham delivered a lecture on July 9 on the "Natural History of Madeira."

The degree of D.Sc. was conferred on Mr. H. E. Magee, for a thesis on "The Influence of Food on the Respiratory Exchange of the Ruminant."

EDINBURGH.—The following are among the changes announced recently in the staff of the University: Prof. J C. Meakins, professor of therapeutics, is leaving in September to take up his duties as professor of medicine, McGill University, and physician-in-chief in the Royal Victoria Hospital, Montreal; Dr Bevan B. Baker, lecturer in mathematics, is resigning on being appointed to the chair of mathematics in the Royal Holloway College, Dr. O. S. Gibbs, lecturer in materia medica, has left to take up duties as professor of this subject in Dalhousie University, Halifax

Dr. Frederick Walker, research student in the Geological Department of the University, has been awarded a Rockefeller Travelling Fellowship by the International Education Board. Dr. Walker will undertake petrological research in the Geophysical Laboratory of the Carnegie Institution of Washington.

LONDON.—The hundredth anniversary of the foundation of University College will be celebrated in 1926, and Sir Gregory Foster asks members and friends of the College to send records, reminiscences, pictures, photographs, etc., which are being collected with a view to the production of a history of the College as a part of the Centenary Celebrations. All documents will, in due course, be returned unless the owners desire to present them for the College archives. Communications and parcels (marked "Centenary") should be sent to Sir Gregory Foster at the College.

The Sharpey Physiological Scholarship, of the annual value of 160*l*., founded in memory of Prof. William Sharpey, will shortly be filled, on the recommendation of the Faculty of Medical Sciences of University College, London. The Scholar has opportunities for research, and takes a small share in teaching and demonstrating to students. Applications should be sent to the Secretary of University College, London (Gower Street, London, W.C.1), not later than Saturday, July 26.

ST. ANDREWS.—Applications are invited for the post of lecturer in chemistry in University College, Dundee. Preference will be given to candidates who have specialised in physical chemistry. Applications should be received (in triplicate) by the Secretary of the University by, at latest, August 31.

SHEFFIELD.—The following appointments have been made: Dr. G. A. Clark, to a lectureship in

physiology; Mr. E. F. Baxter, to an assistant lectureship in mathematics.

THE Technical College, Bradford, invites applications for the headship of its newly established department of commerce and banking. Particulars of the post and forms of application may be obtained from the principal, to whom the completed forms must be returned by, at latest, July 28.

THE British Research Association for the Woollen and Worsted Industries is inviting applications, to be received not later than July 31, for research fellowships and advanced scholarships The fellowships will each be of the maximum annual value of 200*l*, and are tenable, in the first place, for one year, at an educational institution or elsewhere if suitable resources are available. The advanced scholarships are open to students and others, and are designed to enable the scholar to specialise Courses of training in research work should generally be included in a candidate's proposed curriculum. Applications, with particulars of past records, proposed course of work, and so on, should be addressed to the Secretary, British Research Association for the Woollen and Worsted Industries, Torridon, Headingley, Leeds.

EDUCATIONAL RESEARCH appears to have been pursued during the past two or three years with extraordinary enthusiasm in the United States. According to the Biennial Survey, 1920–22, of the Bureau of Education (Bulletin, 1923, No. 42) no less than 80 city, state, and university bureaus for educational research have been maintained, experiments were extensively carried on in all phases of school administration and instruction in numerous institutions, including 22 college and university laboratory schools and about 50 experimental schools for "progressive education," while from numerous presses issued an abundant stream of articles, monograph series, reports, and books Among the national educational organisations which play a prominent part in promoting educational research are the American Council on Education (now closely associated with the American University Union in Europe), which studies the larger questions of educational policy, the Educational Research Association, the National Society for the Study of Education, the National Society of College Teachers of Education, the Carnegie Foundation for the Advancement of Teaching, and many others. The Bibliography appended to the Bulletin comprises 543 items. Those classified under organisation and administration deal largely with plans for classification in ability groups to the end that America may have no mute inglorious Miltons.

THE following awards, tenable at the Imperial College of Science and Technology, South Kensington, during the year 1924–25, have been made by the Governing Body of the College: (*a*) The Henry George Plimmer Fellowship in pathology to Mr. H. R. Hewer, for a continuation of his research on "The Rôle of Stimuli received by the Eye in the Colour Changes of Amphibia and Nerve Supply of the Pituitary", value about 300*l*. (renewal). (*b*) The Gas Light and Coke Company's Research Fellowship, established by the Company for the purpose of encouraging experimental research in relation to carbonisation, gaseous fuels and combustion, to Mr. F. R. Weston, for a continuation of his research on "The Spectroscopic Investigation of the Flames of Carbon Monoxide and Hydrogen and matters cognate thereto"; value 200*l*. (renewal). By the Trustees of the Beit Fellowships for Scientific Research: Research Fellowships of the value of 250*l*. each to Mr. O. M. B. Bulman, for a continuation of his work on "Stratigraphical Geology, The Fauna of the Shineton Shales" (renewal); Dr. W. E. Downey, for research on "Photochemical Problems"; Mr. L. A. Harvey, for research on "The Nature and Function of the Cytoplastic Inclusions (Mitochondria and Golgi Bodies) in the Cells of Vertebrates"; Mr. R. Quarendon, for research on "The Combustion of Gases in Nitrous Oxide."

THE *University Bulletin* issued by the Association of University Teachers has until recently been confined mainly to recording the activities of the Association. The June number includes several articles of a more general nature. Among these is one by Dr. Brodetsky, reader in mathematics in the University of Leeds, on the anti-Jewish policy said to be prevalent in certain universities in Poland and Austria. The admission of Jews to these universities is severely restricted by applying what is known as the "Numerus clausus" principle, which consists in limiting the proportion of students belonging to a particular race to the ratio between the total number of persons of that race in the country and the total population of the country. Many Jews have in consequence gone from Austria to Italian universities, where they are welcomed. In an article on "A new residential university," Principal Childs, of University College, Reading, describes the circumstances in which his college is renewing its application for the grant of a university charter. Faculty organisation is discussed by Mr C. B. Fawcett, reader in geography in the University of Leeds, who advocates reversion on the part of the newer universities to the medieval plan of a general faculty for all non-professional studies and the discontinuance of the practice of awarding several different first degrees—B.A., B.Sc, B.Com., a practice which makes for confusion and misunderstanding, and obscures the essential unity of knowledge.

THE progress of engineering education in India in recent years cannot be said to have kept pace with industrial developments. The official quinquennial Report on Education in India, 1917–22, shows that although during this period expenditure on colleges of engineering and other technical and industrial schools increased by 80 per cent, the number of students in the four Government engineering colleges decreased from 1319 to 1236, and in the other institutions increased only from 13,202 to 15,000. Doubtless there is in India a considerable amount of education in engineering which does not figure in the official returns, but in view of the extent and importance of industrial enterprises already established and the boundless field open to development, these figures must be regarded as astonishingly small, and suggest the question. What would have been the condition of India to-day if the Government's expenditure during the past fifty years on education had been directed by a policy aiming primarily at the development of the material resources of the country instead of being devoted almost exclusively to the dubious benefits of literary curricula on the lines of those of western schools. In Western India, there are signs of a growing appreciation of the benefits of engineering and other technical education, there being keen competition for admission to such institutions as the N.E.D. Civil Engineering College at Karachi, the Victoria Jubilee Technical Institute of Bombay, and the Poona Engineering College, notwithstanding that comparatively high fees are charged.

Early Science at the Royal Society.

July 17, 1661. Sir Paul Neile having mentioned, that the king had, within four days past, desired to have a reason assigned, why the sensitive plants stir and contract themselves upon being touched; it was resolved, that Dr. Wilkins, Dr Clarke, Mr. Boyle, Mr. Evelyn, and Dr. Goddard, be curators for examining the fact relating to those plants.

July 20, 1664. Notice being given, that some ships were ready for Guinea, it was desired, that such, as had inquiries to be made in those parts, might prepare them against the next meeting.

1687. Mr. Hooke shewed the experiment of vibration of the rods, as a pendulum, which was by suspending a large Indian-cane of about thirty feet long by two pack-threads about eight feet in length: by which it was plain how the weight of such rods or poles for communication of traction or pulsion at a distance might not only be made to move freely and with ease, but also be in the nature of a sway. The same thing was also tried with a large scaffold-pole of about forty feet long.

July 22, 1663. Sir Robert Moray mentioned, that the king had made an experiment of keeping a sturgeon in fresh water in St. James's Park for a whole year: it was moved to kill it, and to see how it would eat.—He related that prince Rupert had made a new kind of gunpowder, in strength so far exceeding the best English powder, that trial being made with a powder-trier, it was found to be in the proportion of 21 to 2. It was desired, that a trial of it might be made before the society.

1669. The society being made acquainted by Mr. Oldenburg, that Mr. Edward Diggs intended to go shortly to Virginia, and offered his services for philosophical purposes; it was ordered that the inquiries formerly drawn up for that country should be recommended to him.

July 23, 1662. The amanuensis was ordered to translate from the French Monsieur Huygen's letter to Sir Robert Moray, dated at the Hague, July 14, 1662, containing some objections to some parts of Mr. Boyle's "Defence of the doctrine touching the spring of the air" against Franciscus Linus and Mr. Hobbes.

1684. Upon a complaint of Mr. Flamstead, that he had been reflected upon by Mr. Hooke in the minutes of the society, it was ordered that a line should be drawn through the places complained of, and that there should be written on the side, "cancelled by order of council": and that the journal-book should be brought to the next meeting of the council, who should see it done.

July 24, 1679. Mr. Haak produced a book intitled "Propositions of Optic Glasses," printed at the theatre at Oxford. Mr. Hooke who had read somewhat of the book, said, that he had not found anything in it, which was new, and that it contained some propositions about the place of the image, which were not true: that it came far short of the theory of optics now well known, which he conceived to have been first well understood by Kepler, and highly improved by Des Cartes.

July 25, 1667. The experiment of opening the thorax of a dog made at the last meeting not having succeeded, it was ordered to be made again at the next; and Dr. King was desired to bring in writing an account of that whole operation, though it failed.

July 26, 1682. Dr. Grew read a letter from Dr. Coga, Vice-chancellor of the university of Cambridge, wherein he mentioned, that Hevelius's last book was not to be found in that university.

Societies and Academies.

LONDON.

Physical Society, June 13.—Mr. F E. Smith in the chair.—G. E. **Bairsto**. On a method for the synchronous and instantaneous illumination of objects rotating or vibrating at very high speeds. It is capable of giving instantaneous photographic records, and gives a precision of the order of half a microsecond. It is much more precise and able to give a more intense spark than any contact breaker and coil method.—E. A. **Owen**, N. **Fleming**, and Miss W. E. **Fage**: The absorption and scattering of γ-rays. The absorption and scattering of γ-rays from radium filtered through 23 mm. of lead have been measured in magnesium, aluminium, zinc, tin, and lead. Assuming that the mean effective wave-length of the radiation employed is 0·021 Å, the experimental results are consistent with the following statements: (i.) When γ-rays traverse matter, the characteristic radiations of the absorbing medium are excited; (ii.) the atomic fluorescent absorption coefficient of γ-rays depends upon the wave-length of the incident radiation and the atomic number of the absorber according to the law $\tau/\rho.\omega = K\lambda^3 N^4$, which holds for X-rays; (iii.) the radiations which accompany this fluorescent absorption are the characteristic radiations of the K, L, M, . . . series of the absorbing elements; (iv.) the absorption of γ-rays in light elements is due almost entirely to scattering; (v.) the pure atomic scattering absorption coefficient is proportional to the atomic number of the absorber; (vi.) in addition to fluorescent and scattering absorption, a true absorption exists, the atomic coefficient of which is proportional to the atomic number. Compton's formulæ would account for the experimental results if the wave-length of the incident radiation were 0·020 Å. Jauncey's formulæ would require the wave-length to be 0·029 Å.—W. N. **Bond**: The flow of compressible fluids, treated dimensionally. The method of dimensions treatment that is applicable to the pressure gradient at a point in a system through which non-compressible fluids of finite viscosity are passed, is extended by means of the thermo-dynamical equations for gas flow to the case where appreciable changes in density of the fluid occur, but where no heat passes across the walls of the system. The theory is developed in detail only for the case of flow through a straight parallel-walled tube, and has been tested by experiments in which water and air at high velocities pass through small tubes. The air in some experiments had a velocity of more than two-thirds of the velocity of sound in the air. Errors due to moisture, pulsating flow, heat conduction through the walls, and proximity to the entrance to the tube are small; an error of moderate amount is attributed to the partial neglect of the variation of the variables over the transverse section of the tube.—D. B. **Deodhar**: Note on Israj, a remarkable Indian stringed instrument.

Aristotelian Society, June 16.—Prof T. Percy Nunn, president, in the chair.—A. D. **Lindsay**: Sovereignty. The theory of sovereignty is the storm-centre of political theory. For one school it is inherent in the very conception of government, for another it is nothing but a stone of stumbling, an anachronistic theory to be got out of the way as the essential preliminary to any solution of social questions. Austin approaches the doctrine of sovereignty with the purpose of defining law. Law is essentially a command and depends therefore on a distinction between the sovereign and the subjects. The originality of his theory is that he gives up all attempts to derive the

right of the sovereign from a supposed social contract, and bases it on the previous relation between him who commands and him who obeys. The command is a law consisting in the fact that the person who obeys has been in the habit of obeying the person who commands. Sovereignty is thus based on fact. As constitutional government developed, political theorists tried to describe it in terms of sovereignty. They invented a new kind of person, the people, the general will, the state or the nation, which they distinguished from the individuals composing the community. Bosanquet's "Philosophical Theory of the State" is a theory of sovereignty which he describes as "the general will" and represents as diametrically opposed to the Austinian. He is dealing, however, with a quite different question. He is showing that the real basis of law, as of everything else in society, is the whole of society. What is wanted is a link between this common life of society and the political machinery. The true theory of the sovereignty of the constitution maintains that the link between the social and juristic aspect of the State is the adherence by the great mass of the members of a society to a definite principle of settling differences

Mineralogical Society, June 17.—Dr. H. H. Thomas, vice-president, in the chair.—Miklós **Vendl**: The chemical composition and optical properties of a basaltic hornblende from Hungary. Complete determinations were made, all on the same sample of material, of crystals of a black hornblende occurring in volcanic tuff near Lake Balaton. The mineral is rich in titania, alumina, ferric iron, and alkalis, and the composition is expressed by the mixing of simple metasilicate molecules (including 14·62 per cent. H_2SiO_3) with aluminate (14·40 per cent. $MgAl_2O_4$) and ferrate (4·32 per cent. $MgFe_2O_4$).—G. **Abbott** and W. A. **Richardson**: The micropetrography of the structures of the magnesian limestone of Fulwell. The structures of the magnesian limestone show a wide variety of forms ranging from simple spherical concretions to highly complex coral-like masses The more complex types are built up by a combination of rods, tubes, and bars. The microstructure shows more uniformity. The prevailing type is finely granular but crystalline. Where impurities or lines of pigmentation are present the matrix becomes quite microcrystalline as a rule, whilst on the borders of cavities there is a coarser growth. Banded pigmented forms show the same structure as banded chert. Spheroids have either a coralloid structure, or if solid are microcrystalline at the centre with a radial crystallisation towards the surface. The microstructure by itself throws little light on the origin.

Royal Statistical Society, June 17.—J. **Hilton**: An inquiry by sample: an experiment and its results. At the end of 1923 a need was felt of a more detailed and intimate analysis of the million and a quarter or more workpeople in Great Britain who were then being returned week by week as unemployed; and it was evident that such an investigation must be by sample, and that the information desired was of a kind that necessitated personal interviews. It was decided to "tab" every hundredth claim on the live claim file at each Exchange, and invite the claimants thus indicated to attend in the manager's room for interview. Every Exchange was given a different point on its live claims file at which to start, and the starting points were distributed as evenly as possible over the whole occupational classification. The interviews took place in the week ended November 10, 1923, and 9997 reports were received. Comparison with the results of previous inquiries showed that the 1 per cent. sample is nowhere very wide of the mark, and has answered most of its purposes quite as well as a 10 per cent. or 33 per cent. inquiry. The sample only becomes untrustworthy when very small absolute numbers are involved.

Royal Meteorological Society, June 18.—Mr. C. J. P. Cave, president, in the chair.—C. K. M. **Douglas**: Further researches into the European upper air data, with special reference to the life history of cyclones. The temperature in the troposphere is much higher over a Bjerknes' "warm sector" than over the other parts of a cyclone. This leads to the conclusion that a cyclone is superficial in its initial stages. Relevant observations are few, since the development of a cyclone usually takes place in the Atlantic. A large part of the great increase of kinetic energy observed when a cyclone develops is supplied by a convectional overturning between adjacent warm and cold masses of air The cold mass must have a depth of fully 6 or 7 kilometres, or about the depth of the troposphere in high latitudes in winter. In an appendix it is shown, by means of a criterion due to L. F Richardson, that an inversion can only exist at a very small angle with the horizontal without becoming increasingly turbulent, a conclusion which is confirmed by observation. In a developing cyclone, the slope of the surface of separation between the cold and warm masses is of the order of 1 in 50, and the inversion is inevitably destroyed by mixing.—Miss L. F. **Lewis**: The effect of the source of air on its temperature at 4000 feet and 10,000 feet. During the winter months, the chief factor in determining the temperature of the air up to 2000 feet is its passage over a large expanse of land or sea. Air from the Continent is cold, while air from the Atlantic is relatively warm. On the Atlantic, however, some polar effect is shown when the path of the air is followed back for two days or more. At 4000 and 10,000 feet the chief factor is now the north to south component of the air's path, while the land and sea effect is small. Trajectories show that it is the latitude of the air two days before or even longer that determines the temperature — L. H. G. **Dines**: A simple electrical time-marking system for use with self-recording meteorological instruments. The simple system of synchronous electrical time-marking installed a few years ago at Valencia Observatory, Cahirciveen, Co. Kerry, is described. A central clock operating hourly and minute contacts in series closes an electrical circuit once an hour. The circuit includes electro-magnets acting on suitable portions of the recording mechanism of the self-recording instruments which it is desired to include in the scheme. By this means time marks are easily obtained to an accuracy of a second or less.

Linnean Society, June 19.—Dr. A. B. Rendle, president, in the chair. — C. E. **Salmon**: A hybrid between *Carex remota* and *C. divulsa*. This occurred near Mayfield, in Sussex, in one large clump with a quantity of *C. remota* and a little *C. divulsa*. It differs from *C. remota* by its more scabrous stem, only one (or at most two) bracts, spikelets male at the summit, or even wholly male, and in other particulars. *C. remota* × *divulsa* seems extremely uncommon and is perhaps new. — T. A. **Dymes**: The seed of *Orchis latifolia*. The seeds of the British Dactylorchids fall into two groups: (1) Maculatæ, and (2) Latifoliæ. A form, agreeing in other respects with *O. latifolia* L., the seeds of which are obviously pure, has been found. The seeds belong to group (2) Latifoliæ, and are very like those of *O. prætermissa* Druce, and it seems probable that the two forms are close allies of the same species.—J. H. **Priestley** and Miss Lorna I. **Scott**: Leaf and stem anatomy of *Tradescantia fluminensis*

Vell. Vascular development in the leaf is first basifugal and afterwards basipetal, and the backward development of the subsidiary veins through the leaf sheath is associated with the subsequent development of the system of peripheral bundles, which lie in the sclerenchyma very near the periphery of the adult stem. Thus the functional vascular supply to the leaf passes through two stages in the stem. In the young internode, communication is maintained by means of the medullary and perimedullary bundles; as the growing internode extends in length the xylem of these bundles is disorganised, but at this time the peripheral bundles are differentiated throughout the internode and become functional.—T. B. **Blow**: Charophyta collected during a recent visit to Madagascar. These plants are interesting by reason of their affording a possible means of preventing the spread of malaria by acting as larvicides. The country covered was the east coast line, where are great marshes and much water, and where malaria is rampant, the higher ground around the capital, Tananarive, where the climate is much healthier, the mountainous portions near Antsirabe, where mosquitoes scarcely exist, and the district of the great Lake Alaotra, which is probably the most malarious part of Madagascar. It was noticed in connexion with several species of Chara that, where they abounded, there were rarely any mosquito larvæ in the water. The species that seemed to keep the water quite free of mosquito larvæ were as follows: *Chara Zeylanica*, *C. gymnopitys*, *Nitella Roxburghii*, and some other species of Nitella probably new.

DUBLIN.

Royal Dublin Society, May 27.—Prof. E. A. Werner in the chair.—W. R. G. **Atkins**: Notes on the filtration and other errors in the determination of the hydrogen ion concentration of the soil. As a general rule, the effect of increasing or decreasing the soil to water proportion, within limits, does not alter the P_H value by as much as 0·1 for soils between P_H 6 and P_H 8. With more acid or more alkaline soils larger alterations are thus caused. For lightly buffered acid soils one part of soil to two parts of water seems a safe proportion to adopt; for other soils a one to five proportion is convenient and, apparently, trustworthy. The P_H value of some soil extracts is markedly modified by filtration, even when a first filtrate is rejected. Both untreated and acid-extracted filter-papers may reduce the acidity. The use of large volumes, about 160 c.c., of filtrate, and a filter appropriate to the soil, reduces these errors: where possible, cleaning by the centrifuge is desirable. The fibres of acid-extracted papers act towards indicators as if as acid as P_H 4·8, but washing was not found to render them less acid. Unextracted papers are at about P_H 7·0-7·6, and give up traces of alkali to distilled water. The indicator brom-cresol green is to be preferred to methyl red for the same P_H range.—J. L. **McWhinney**: The soil fauna of a permanent pasture. A census of the invertebrate fauna resident on the surface, and in the soil to a depth of nine inches, of a permanent pasture forming part of the experimental farm of the Albert Agricultural College, Glasnevin, Co. Dublin, reveals a considerably greater density of population than has been found by other workers elsewhere. If the soil be dried before the count is made, numbers of the smaller species may be overlooked.

EDINBURGH.

Royal Society, June 2.—Prof. F. O. Bower, president, in the chair.—D. A. **Allan**: The igneous geology of the Burntisland district. Penetrating the Lower Carboniferous rocks of this area is a group of eleven volcanic necks, one of which is recorded for the first time. An examination of the boulders in the agglomerate has failed to produce material younger in age than the surrounding rocks. The lava flows comprise olivine basalts of the Dalmeny and Hillhouse types, together with a pyroxene-rich variety now designated as being of the Kinghorn type. From a consideration of the variation of the lavas, it has been possible to establish upon broad lines a series of zones. The intrusions include olivine basalts, teschenites, olivine dolerites, olivine-free dolerites, and quartz dolerites, the last named being probably the latest in development.—Ada M. **Malcolm**: The magnetic quality of very pure nickel. A nickel bar was examined by the magnetometric method (*a*) in a horizontal position, (*b*) in a vertical position, with and without an additional stress of ½ kgm. weight—the magnetising fields being of very low order. With the same bar in the horizontal position, complete hysteresis cycles were made, the field being increased in one case step by step, and in the other being continuously varied. The constant values of the susceptibility (K) and the permeability (μ) were calculated: $K = 4·17$ to $4·20$; $\mu = 53·53$ to $53·77$. A circular coil of nickel wire was also used, and its saturation point determined by means of a ballistic galvanometer. The graph tended to become straight in the neighbourhood of a field of 100 gauss. The purity of the nickel was not less than 98·5 per cent.—Winifred J. **Smith**: The law of recurrence and decay of after-images. The sequence of colours observed, after exposing the eye to white light for a given period, can be represented graphically by the combined effect of three exponentially decaying periodic curves, representing the sensations of red, of blue, and of green. Differential equations were derived from the curves chosen to represent the experimental results. The form of these differential equations suggests two different physical analogies, one to the interaction of three condensing electric circuits, and one to the motion of elastically connected masses.—H. **Briggs**: Apparatus to facilitate the use of an oxygen-carbon dioxide mixture on the treatment of carbon monoxide poisoning. The orthodox treatment by means of oxygen of a case of carbon monoxide poisoning is not especially effective, being apt to bring about sub-normal breathing at a time when the reverse is needed. Henderson and Haggard, of Yale University, have developed the method of treatment by oxygen plus 5 per cent. of carbon dioxide, a mixture which has not the same disadvantage. It stimulates breathing from the moment of application, and reduces the chance of serious sequelæ. The mixture is now obtainable commercially in America under the name of "carbogen." As carbogen cannot yet be bought in Great Britain, it was necessary to devise an apparatus to make it. The liquid carbon dioxide in a large-sized "Sparklet" bulb can be discharged into an oxygen cylinder of 290 litres capacity, the cylinder being then charged with oxygen to the standard pressure of 120 atmospheres. The mixture so made contains 5 per cent. carbon dioxide.—R S. **Vaidyanathaswamy**: On mixed determinants This paper deals with the extended determinants, containing suffixes of two different kinds (the "signants" and "non-signants" of Rice), and leads up to the concept of "inert suffixes" of matricular invariants, and the concept of "extensional invariants." Some features of the determinant-theory advanced are: (1) a new account of the "decomposition" of a determinant into determinants of lower dimensions, as a quoted development by linkage of "suffixes"; (2) a systematic use of "one-dimensional determinants"

as the ultimate entities of determinant-theory; (3) a new and improved version of the theory of multiplication of determinants.

PARIS.

Academy of Sciences, June 16.—M. Guillaume Bigourdan in the chair.—Louis **Gentil**: The structure of the *Dorsale Tunisienne*.—Charles **Richet** and Mme. A. **Le Ber**: The relation between the time of action and the concentration of a sterilising substance (hydrogen peroxide). In sterilising a culture with an antiseptic two factors intervene, the concentration of the antiseptic and the period of time during which it is allowed to act. Results of measurements of the minimum sterilising dose of hydrogen peroxide are given for times varying between 3 minutes and 15 hours.—E. **Leclainche** and H. **Vallée**: Symptomatic anthrax and gas gangrene in cattle. Clinical and bacteriological studies of *B. septicus* and *B. chauvœi*, and their pathological and immunising effects on cattle and horses.—A. **Desgrez**, H. **Bierry**, and L **Lescœur**. A mode of differentiation of sulphurous waters.—Ch. **Depéret** and L. **Mayet**: Reply to the observations of S. Stefanescu on the phylogeny of elephants.—Jean **Effront**: The absorbing power of vegetable pulps.—Paul **Vuilemin**: Anomalies of leaves caused by alloplasy.—**de Montessus de Ballore**: The unsymmetrical curves of Gauss.—V **Illavaty**: Remark on the quasi-asymptotic curves of Bompiani.—J. A. **Schouten**: The conformal and projective connexions of Cartan and the general linear connexion of Konig.—R. H. **Germay**: Application of the method of successive approximations to a lemma of Weierstrass and to its generalisation.—Georges J. **Rémoundos**. Couples of functions which satisfy an algebraic equation.—A. **Bloch**: The theorems of M. Valiron on integral functions, and the theory of uniformisation.—R. **Gosse**: Explicit integrals of equations of the first class, $S=f(x, y, z, p, q)$, which admit an intermediate integral of the first order.—André **Metz**: Concerning the geometry of a disc turning in a Galilean system.—C. **Kolossoff**: The torsion of prisms having a right-angled triangle as base.—A. **Gros**: Finite bending of a circular ring compressed diametrically.—J **Seigle**: Some observations relating to the effects of permanent torsions on steels.—Louis **Roy**: Electrodynamical and electromagnetic induction in continuous media in motion.—Y. **Rocard**: Extension of some results of the kinetic theory of gases.—G. **Athanasiu**: The distribution of energy in the mercury arc spectrum. Measurements were made on three groups of lines, using a spectrometer with a quartz optical system, and a thermocouple for reading the energy of the radiations. The mercury arc lamp was maintained with a current of 3·75 amperes, the voltage varied between 30 and 80 volts It was found that the energy curves of lines belonging to the same series had the same general shape. The ratio between the intensities of two lines of the same series remained practically constant when the energy consumed by the arc lamp varied between 100 and 300 watts.—Jean **Lecomte**. Quantitative studies on the infra-red absorption spectra of organic substances. In the infra-red region the opacities of the different substituting groups are not additive.—A. **Dauvillier**: Spectrographic researches on the A. H. Compton effect. The Compton effect only appears in the case where the selective absorption is very small, and it is far from having the generality predicted by the theory.—Max and Michel **Polonovski**: The derivatives of eserine obtained by hydrogenation.—Léon **Guillet**: The influence of the velocity of cooling on the properties of commercial aluminium. The mechanical properties and the electrical resistance of aluminium are modified by the velocity of cooling, at least, if the percentage of silicon is a little high. The properties of commercial tempered aluminium do not sensibly change on keeping.—K. v. d. **Grinten**: Adsorption and cataphoresis. An application of the method of electric transport observed with the ultramicroscope.—Sir William J. **Pope** and F. G. **Mann**. 1.2.3 triaminopropane. Its preparation; formation of complex metallic derivatives. The method of preparation of this triamine given by Curtius and Hesse is tedious and not without danger. The new method involves the following steps: citric acid, acetone dicarboxylic acid, di-isonitroso-acetone, diaminoacetone, diacetyldiaminoacetoxine, 1.2.3 triaminopropane. The yields are good throughout, and with the base thus obtained the complex cobalt and rhodium compounds $[Co(NH_2 . CH_2 . CH(NH_2) . CH_2NH_2)_2]Cl_3$ and $[Rh(NH_2 . CH_2 . CH(NH_2) . CH_2NH_2)_2]Cl_3$ have been prepared. The stereo-chemical study of this new type of metallic complex is being carried out.—Marcel **Delépine**: The origin of fenchol in the reaction of Bouchardat and Lafont. Turpentine treated with either mineral acids or organic acids always gives a mixture of borneol and fenchol esters.—C **Vournazos**: The formation of the bismuthamines.—H. **Gault** and Y. **Altchidjian**: The dissociation of hexadecene at high temperatures.—R. **Locquin** and L. **Leers**: The dehydration of some new pinacones. Starting with the pinacones $R(CH_3) . C(OH) . C(OH) . (CH_3)_2$, hydration by Meerwein's method yielded the ketones $R(CH_3)_2 . C . CO . CH_3$ (R being normal propyl, butyl, or amyl) with no indication of the presence of the isomeric $(CH_3)_3 . C . CO . R$. Ketones of the latter type were prepared by another method for the purpose of comparison.—E. **Raymond** and G **Clot**: The acetyl index of fatty materials. The method proposed is based on the volume of methane produced by the action of magnesium methyl iodide in anisol solution on the dried fat, with correction for fatty acid present.—P. **Lebeau** and J. **Marmasse**: The quantity and nature of the gases evolved by solid combustibles under the action of heat and a vacuum: lignites.—L. **Cayeux** The felspathic grits of the Hercynian Chain and the products of Permo-Triassic evaporation.—Gaston **Astre**: The tectonic units of the Sierras del Cadi, of Port del Compte and of some adjacent massifs (Catalanian Pyrenees).—M. de **Lamothe**: The tectonic evolution of the relief of the southern Vosges during the Quaternary, and solution of the problem of Noir-Gueux.—Ch. **Mourain**, **E. Salles**, and G. **Gibault**: The value and variations of the terrestrial field at Val-Joyeux, near Paris. Curves summarising results obtained with the self-recording apparatus installed at the Val-Joyeux Observatory, showing the annual variation of the terrestrial electric field as a function of the period of the year, and also of the time of day.—E. **Bauer**, A. **Danjon**, and Jean **Langevin**. Crepuscular phenomena on Mont Blanc.—W. **Kopaczewski** and M. **Bem**: The electrical conductivity of mineral waters as a means of their control.—H. **Colin**: The sugar beet and the forage beet.—Mme. B. **Brilliant**: The water content in leaves and assimilating power.—Fernando de **Buen**: The biology of the sardine in Galicia (Spain).—Louis **Fage**: A new type of Mysidacea in the subterranean waters of the island of Zanzibar.—André **Leroy**: The transparency of the shells of hen's eggs, and the modifications which it undergoes with time.—Ch. **Pérard**: Researches on the coccidia and coccidoses of the rabbit.—T **Mutermilch**: The nature of the heterologue hæmolysins (Forssmann).—N. **Ishimori** and T. **Metalnikov**: The immunisation of the caterpillar of *Galleria melonella* by non-specific substances.

WASHINGTON, D.C.

National Academy of Sciences (Proc. Vol. 10, No. 5, May).—**E. Tomanek** and **E. B. Wilson**: Is pneumonia increasing? Statistics have been gathered of all forms of pneumonia in the United States registration area for the period 1900–1920. Making due allowances for the increase of registration area during that period, for the changed standard of life and economic conditions, and for difficulties of diagnosis, it is inferred that the disease is neither increasing nor decreasing.—**G. A. Miller**: Prime power substitution groups whose conjugate cycles are commutative.—**R. L. Moore**: (1) An extension of the theorem that no countable point set is perfect (2) Concerning the prime parts of certain continua which separate the plane.—**J. R. Kline**: Concerning the division of the plane by continua.—**F. B. Sumner**: The partial genetic independence in size of the various parts of the body. Castle's figures for the correlation between total size and the size of individual organs or members are calculated from data from a "mixed population." Much lower correlations are obtained if sets of calculations are confined to a single race.—**W. E. Castle**: Are the various parts of the body genetically independent in size? A reply to the preceding paper. The calculations were based on a "mixed population" deliberately. It was sought to discover whether with change in general body size through genetic (not environmental) agencies there was a corresponding change in different parts of the body; hence it was desirable to start with differences in body size as great as possible.—**L. L. Woodruff** and **E. L. Moore**: On the longevity of *Spathidium spathula* without endomixis or conjugation. This organism was cultured by daily isolation in standard beef extract for 444 days, after which the animals suddenly appeared abnormal and died. The graph giving the average daily rate of division of the four lines of culture used shows only such fluctuations as may readily be accounted for by external factors. Pedigree cultures of *S. spathula* have shown progressive lengthening of life without endomixis or conjugation, and it is now considered that the organism can reproduce indefinitely in this way, given suitable environment.—**D. L. Webster**: A possible explanation of tertiary line spectra in X-rays. Objection is raised to the hypothesis of Clark and Duane on the grounds that the energy of the tertiary beam would be very small and that the narrow peak observed in the ionisation curve cannot result from reduction by filtering on emergence from the radiator of a continuous spectrum. It appears more probable that the atoms ejecting the photo-electrons are the source of the radiations. Data from the spectra of thin targets are in general agreement with this hypothesis.—**G. L. Clark** and **W. Duane**: On the theory of the tertiary radiation produced by impacts of photo-electrons. The short wave-length limits and the angles corresponding to them, calculated from Webster's theory, are not in accord with experimental and theoretical results obtained by Clark and Duane except for elements of low atomic number. This is to be expected since the difference between the theories resolves itself into a difference, which increases rapidly with the atomic number of the element, between a critical absorption frequency and that of a given emission line. Clark and Duane's theory also offers an explanation of the radiation found by de Broglie on the long wave-length side of radiations from a tungsten-carbon target.—**S. K. Allison** and **W. Duane**: Absorption measurements of certain changes in the average wave-length of tertiary X-rays. The "hump" of tertiary radiation in Clark and Duane's experiments shifts towards longer wave-length with increase in the angle between the primary and secondary X-rays. Using the secondary radiation of maximum intensity and employing a polished silver plate as secondary radiator, the effects of tellurium, antimony and iodine screens were investigated. An appreciable quantity of radiation shifts over to longer wave-lengths at angles greater than 40°.—**I. S. Bowen** and **R. A. Millikan**. The series spectra of the stripped boron atom (B III.). All the lines which, from theoretical considerations, can be expected in any strength from a boron atom deprived of all valence electrons, have been identified. Lines hitherto not identified or now discovered occur at λλ 4499·0 A, 2077·79 A; another line at 677·1 A is shown to be a doublet with a separation of 0·15 A (correct to at least 0·01 A) or in frequencies, of 32·7 cm.$^{-1}$. The line at 758·5 A is the first term of the sharp series of B III.

Official Publications Received.

Mellon Institute of Industrial Research of the University of Pittsburgh. Industrial Fellowships Pp. viii+21. (Pittsburgh, Pa.)

Bulletin of the National Research Council. Vol. 8, Part 2, No. 44: The Continental Shelf off the Coast of California. By Andrew C. Lawson. Pp. 23. (Washington, D.C.: National Academy of Sciences.) 25 cents.

Fourth International Congress of Refrigeration, London, June 1924. First International Commission of the International Institute of Refrigeration. Reports and Communications presented by the President, H. Kamerlingh Onnes. Pp. viii+257. (Leiden · Edouard Ijdo.)

Smithsonian Institution: United States National Museum. Contributions from the United States National Herbarium, Vol. 22, Part 8: New American Asteraceæ. By S. F. Blake. Pp xi+587-661+plates 54-63. (Washington: Government Printing Office.) 20 cents.

Meddelanden från Statens Skogsforsoksanstalt. Halfte 21, No. 1: Ett Bidrag till Kannedomen om Brunjords- eller Mulljordstypens Egenskaper och Degeneration i sodra Sverige; ein Beitrag zur Kenntnis der Eigenschaften und der Degeneration der Bodenarten vom Braunerdetypus im sudlichen Schweden. Av Karl Lundblad. Pp. 48. Halfte 21, No. 2: Den å Boda Kronopark utforda Gronkvistningen av Tall; die Aufastung an Kiefer im Staatsforst Boda. Av Erik Lundh. Pp. 49-100 Halfte 21, No. 3: Om våra Frammande Barrtrads Vinterhardighet; uber die Winterfestigkeit fremder Nadelbaume in Schweden. Av Nils Sylven. Pp. 101-148. (Stockholm.)

Transactions of the Optical Society. Vol. 25, No. 3. Pp. 97-148. (London: Imperial College of Science.) 10*s*.

University of Illinois Engineering Experiment Station. Bulletin No. 140: The Viscosities and Surface Tensions of the Soda-Lime-Silica Glasses at High Temperatures. Part 1: The Viscosity of Glass at High Temperatures. By Prof. Edward W. Washburn and George Reed Shelton. Part 2: Surface Tensions of Glasses at High Temperatures. By Prof. Edward W. Washburn and Earl E. Libman. Pp. 74. (Urbana, Ill.) 45 cents.

The National Physical Laboratory. Report for the Year 1923. (Published for the Department of Scientific and Industrial Research.) Pp. 228. (London: H.M. Stationery Office.) 13*s*. 6*d*. net.

Ministry of Agriculture, Egypt: Technical and Scientific Service. Bulletin No 44: The Propagation and Cultivation of Citrus Trees in Egypt. By Thos. W. Brown. Pp. vi+88+30 plates. Bulletin No. 45: The Insect Pests of Citrus Trees in Egypt. By W. J. Hall. Pp. iv+30. (Cairo: Government Publications Office.) 5 P.T. each.

Reprint and Circular Series of the National Research Council. No 49: Statement of Activities of the National Research Council for the Year July 1, 1922–June 30, 1923. By Vernon Kellogg. Pp. 16. 25 cents. No. 51: The Higher Agricultural Education of the Future. By E. Marchal. Pp. 6. 20 cents. No. 52: The Specific Heat and Thermal Diffusivities of certain Explosives. By A. M. Prentiss. Pp. 44. 25 cents. No. 53: A List of Research Problems in Chemistry. By J. E. Zanetti. Pp. 9. 15 cents. (Washington, D.C.: National Academy of Sciences.)

Trinidad and Tobago: Council Paper No. 15 of 1924. Agricultural Credit Societies: Report by the Registrar of Agricultural Credit Societies for the Years 1922 and 1923. Pp 12. (Port-of-Spain: Government Printing Office.) 6*d*.

Department of the Interior, Canada. Publications of the Dominion Astrophysical Observatory, Victoria, B.C. Vol. 2, No. 15: Evidence of the Bending of the Rays of Light on passing the Sun, obtained by the Canadian Expedition to observe the Australian Eclipse. By C. A. Chant and R. K. Young Pp. 275-287. (Ottawa: F. A. Acland.)

The Journal of the Institute of Metals. Vol. 31. Edited by G. Shaw Scott. Pp. xi+680+40 plates. (London: 36 Victoria Street, S.W.1.) 31*s*. 6*d*. net.

Proceedings of the Edinburgh Mathematical Society. Vol. 42 (Session 1923-24), Part 1, April. Edited by Dr. Archibald Milne and Dr. T. M. MacRobert. Pp. 59. (London: G. Bell and Sons, Ltd.) 5*s*. net.

Third Report of the Hayling Mosquito Control, May 1923 to May 1924. Pp. 12. (South Hayling: J. F. Marshall, Hon. Director, Seacourt.)

Report of the Director of the Royal Observatory, Hongkong, for the Year 1923. Pp. 18. (Hongkong.)

SATURDAY, JULY 26, 1924.

CONTENTS.

Editorial and Publishing Offices :
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.

Editorial communications should be addressed to the Editor.
Advertisements and business letters to the Publishers.

Telephone Number: GERRARD 8830.
Telegraphic Address: PHUSIS, WESTRAND, LONDON.

Applied Chemistry in Peace and War.

IN a recent issue of the official organ of the Society of Dyers and Colourists,[1] Prof. Gardner reviews impartially and judicially the present position of the British dyestuffs industry, more especially with regard to recent negotiations between the British Dyestuffs Corporation Ltd. (B.D.C.) and the Interessen-Gemeinschaft (I.G.). His article, which is written in non-technical language, should be read by all wishing to obtain a clear perspective of the dyestuffs problem in its national aspects.

It is essential in considering the merits and demerits of the proposed agreement to differentiate clearly between the British dyestuff industry and the B.D.C., a distinction which is daily becoming more pronounced in proportion as the independent dyemakers gain an increasing amount of the home trade in colours. An agreement which is mutually advantageous to the I.G. and the B.D.C. may nevertheless be ruinous to the British competitors of the latter organisation. A criticism frequently made against the recent report of the Dyestuffs Development Committee of the Board of Trade is, that this document emphasises the great technical advances made since the War by British colour chemists, and at the same time urges the need for a continuance of the protection afforded to the industry by the Dyestuffs Act. The two points of view are, however, not inconsistent.

The enormous improvement in manufacturing capacity cannot be gainsaid. It may be recalled that prior to the War, 80 per cent. of British requirements for dyes came from abroad, and principally from Germany; at present "something over 80 per cent." of our home needs are supplied by British makers. It is, however, to secure the remaining 16 per cent. that the directors of the B.D.C. are striving for an arrangement with the great German combine. It is argued, Why should we expend money on research when the results are ours for the asking? Not being chemists, the directorate forgets that there is no finality in chemical industry, and that even now investigations are on foot which may render obsolete many of these precious dyes and also the majority of the commoner ones. To ensure steady growth, the still infantile industry needs protection not only from competition outside but also from apathy and lack of knowledge within the nation.

At the same time, it should be conceded that, so far as the interests of his shareholders are concerned, the chairman of the B.D.C. has done a great work in internal reorganisation and retrenchment, and also, in

[1] W. M. Gardner, "The British Dyestuffs Industry," Journal of the Society of Dyers and Colourists, vol. 40, No. 6, June 1924 (Bradford. Pearl Assurance Buildings, Market Street, 1924) 5s.

view of the possible repeal of the Dyestuffs Act, he has made a very good bargain with a foreign competitor against whom the home industry would be heavily handicapped if the existing restriction on foreign importation were removed.

While these acute discussions are in progress in Great Britain, five lectures delivered by Prof. Haber during the last four years, and recently published,[2] have the sombre significance of the writing on the wall, for the text of his discourses may be taken to be the national necessity of a self-contained chemical industry vital to the public welfare either in peace or war. As the recipient of a Nobel Prize, the lecturer naturally dealt with the more peaceful attributes of the industrial synthesis of ammonia from its elements. But the warlike aspects of chemical science are displayed in the address on "Chemistry in War," delivered to the officers of the Ministry of National Defence (1920), and in the lecture on "The History of Gas Warfare," given last October before the Parliamentary research committee of the German Reichstag. In the former discourse Haber refers to the larger problems of munitions which arose in Germany on the prolongation of the War, and also on the special requirements for chemical warfare. He compares favourably the comparatively humane nature of the casualties inflicted by chemical means with the ghastly and disfiguring wounds produced by flying shrapnel and the other older weapons, and points out that, in spite of the Washington Conference, the fervent wish expressed in England, as in America, for the establishment of an independent chemical industry is due to a recognition of the importance of this trade in the production of chemical munitions of war.

In the lecture to the Reichstag representatives, Prof. Haber traces the development of chemical warfare both before and since the surprise attack with chlorine made by the German army at Langemark on April 22, 1915. He concludes by asserting that the moral indignation displayed in the Entente press during the War was directed principally against German gas warfare, but not against the employment of similar weapons by the Allies.

It is doubtful whether the proposed agreement between the B.D.C. and the I.G. will restrict secret preparations for gas warfare being made by any nation holding a predominant and self-contained position as regards the chemical arts. Our path of safety is to encourage to the utmost the development of research and industrial expansion in an independent national dye industry. G. T. M.

[2] "Fünf Vorträge aus den Jahren 1920–1923: Über die Darstellung des Ammoniaks aus Stickstoff und Wasserstoff; Die Chemie im Kriege; Das Zeitalter der Chemie; Neue Arbeitsweisen; Zur Geschichte des Gaskrieges." Von Fritz Haber. Pp. v+92. (Berlin: Julius Springer, 1924.) 0·65 dollar.

Sir Archibald Geikie.

A Long Life's Work: an Autobiography. By Sir Archibald Geikie. Pp. xii+426. (London: Macmillan and Co., Ltd., 1924.) 18*s*. net.

FROM time to time Sir Archibald Geikie has interested his numerous readers by writing sketches or reminiscences of incidents in his long and busy life. In the volume now before us he has set out in orderly sequence the principal events of his career from early boyhood to a well-earned period of rest. Advancing years may have curtailed his activities, but his memories of friendly intercourse with many distinguished men in all parts of the world, of the almost innumerable functions in which he has taken a prominent part, and the charm of the literary style in which he tells his experiences, remain as fresh as ever.

Born in 1835, Geikie's earliest reminiscences relate to incidents which to many of us seem to belong to ancient history, as, for example, the gathering of the Elders at the Disruption of the Kirk of Scotland, when black coats swarmed like hiving bees in and out of St. Andrew's Church, or the opening of the first railway in Scotland. But interest centres chiefly on the early proclivities of the boy himself, inasmuch as he was destined to become a leader in geology, a noted man of letters and a distinguished public servant.

At the Edinburgh High School, Geikie acquired an appreciation of the Latin classics which has been a joy to him all his life, but a love of Nature was evidenced by a passion for collecting butterflies. It was while so engaged in a limestone-quarry that he first found a fossil. Enthusiastically he broke up block after block, disclosing delicately preserved plants, and realising, not without awe, that he was bringing to the light organisms that had never before been seen by human eyes. Thenceforward the rocks and their fossils became increasingly the subject of his thoughts. Through this incident he became acquainted with Robert Chambers, author (as it appeared later on) of "Vestiges of the Natural History of Creation." He read every book on geology he could lay hands on, but in the "Old Red Sandstone" of Hugh Miller found a greater stimulus than in any other, not so much from the information it supplied as from its revelation of the enthusiasm of a true lover of Nature. From the consideration he received at the age of seventeen from such men as Logan, David Forbes, and Sorby, it may be inferred that he had already shown unusual promise as a geologist.

The time had come, however, for choosing a profession, and to his parents, as to so many others before and since, it appeared that though geology might be

a pleasant pastime, it could scarcely provide a living. They decided therefore to put young Geikie into a bank after two years' instruction in law in the office of a Writer to the Signet. The work proved to be "unspeakably dull," and the two years' training was never completed.

During a holiday in London Geikie returned to his old love. He passed many happy and profitable hours in the galleries of the newly established Geological Museum in Jermyn Street, and about this time (1853) first heard of the Geological Survey, a branch of the public service which had been initiated by De la Beche some ten years before. An interview with Sir Andrew Ramsay, at that time local director, and a walk taken over Arthur's Seat at Ramsay's invitation (issued, as we may suppose, for the purpose of forming an opinion of the young geologist's capability), led to a suggestion that a post on the survey might be found. In the interval of waiting he wasted no time. Some geological work in Skye formed the basis of a communication to the Royal Physical Society of Edinburgh in 1854, his first appearance before a learned society. Determined to continue his literary studies, he matriculated at the University of Edinburgh as a student of the humanities, and though prevented by domestic circumstances from completing the course, he became one of the best scholars of his year and the best writer of English prose and verse. In 1855 he obtained a post on the Geological Survey, and commenced his long career as a professional geologist. Let it be well taken to heart that he had equipped himself not only as a geologist, but also as a scholar and man of letters.

In the next few pages Geikie describes the work of a field-geologist, the simple accoutrement required, and the difficulty country people felt in understanding how he could tell what lay below the surface of the ground without digging. The work was arduous, and according to official regulations occupied nine hours a day, in practice probably much more. He found time and energy, nevertheless, to pursue his classical studies, and even enlivened long tramps home by recitations from his favourite poems. "I look back," he says, "on this period of my life as perhaps the most studious and certainly one of the most delightful that I have been privileged to enjoy." New discoveries in geology quickly followed, notwithstanding MacCulloch's vainglorious boast that he had left nothing in the geology of Scotland that could not have been effected by a surveyor's drudge or a Scottish quarryman. A fossiliferous shale was detected under massive sheets of Old Red Sandstone lava, but the origin and age of igneous rocks began to take first place in Geikie's attentions. In touching upon such questions he conveys his information in language which is intelligible to non-scientific readers; modern scientific technicalities find no place in these pages, when good English serves. For some time Geikie was the sole representative of the Geological Survey in Scotland. On him alone lay the responsibility of mapping a region extending into several counties and calling for much sagacity in dealing with new problems.

In 1860, owing to the death of Prof. George Wilson, who had had it in hand, it fell to Geikie to complete the "Life of Edward Forbes." Some hesitation was felt in entrusting the work to so young a man, but the book was completed and published in 1861, forming the first of a number of charming biographies from the same pen. In the autumn of 1860, Geikie accompanied Murchison on a tour through the Highlands, and though the secret of the Highlands was not yet to be told, his accounts of the hospitalities extended by the many large landowners with whom Murchison was acquainted, make good reading. In the winter, Ramsay having been taken ill, Geikie was called upon to take over the lectures at the Royal School of Mines and the popular geological addresses to working men in the theatre of the Jermyn Street museum. These addresses were delivered by the most eminent men of the day on their respective subjects and were attended by crowded and intelligent audiences. I have myself seen the theatre full of working men listening spellbound to an exposition by Huxley of the elements of biology.

The relics of the Glacial Period, during which a large part of the British Isles was overridden by ice-sheets, now began to claim Geikie's attention. Boulder clays, sands and gravels, collectively known as "glacial drift," were spread over the country during this period in such quantity as to dominate the soil and often completely to mask the characters of the underlying "solid" formations. A holiday spent in quest of glacial drift led to a communication to the Geological Society of Glasgow in which Geikie reviewed the sequence of events in Scotland and showed the boulder-clay to be the product of an ice-sheet, and not, as was stoutly maintained by many, of floating ice. He obtained confirmation of this view by an exploration of northern Norway.

By this time Geikie's intimate knowledge of a large part of his native country, his appreciation of a landscape, and the geological training by which he was enabled to interpret the significance of the features of the ground, impelled him to the writing of "The Scenery of Scotland." The book, though in direct antagonism to Murchison's cataclysmic opinions, was dedicated to him. The compliment was accepted without demur.

In 1867 a separate branch of the Geological Survey was constituted for Scotland and Geikie was appointed

director. Suitable men for the posts on the new branch were scarce, and among the candidates one at least, who afterwards achieved a great reputation as a geologist, and was in fact an able algebraist, failed to add up correctly against time long columns of pounds, shillings, and pence, a test of the capability of a field-geologist which was insisted on then and for many years afterwards by the Civil Service Commissioners. Friendships with many eminent literary and scientific men continued to ripen. Alexander Macmillan was one of the earliest and most constant. Another old friend, Poulett-Scrope, a high authority on volcanic problems, being desirous that the volcanic regions of southern Italy should be examined by a competent geologist, contributed two hundred pounds for the expenses and suggested to Geikie that he should undertake the examination. The offer was accepted, but a severe fever, developed at Lipari, put an end to the project.

Provision for a chair of geology in the University of Edinburgh having been made by Murchison in his will, he desired to nominate Geikie as the first professor. The Home Office objected to this as an interference with the prerogative of the Crown, and the Science and Art Department objected to two posts being held simultaneously by the same man. The objections were, however, overcome, mainly through the influence of Lyon Playfair, Member of Parliament for the University, and Geikie was appointed in 1871. In this same year he married and travelled to the south of France to visit his wife's relatives, witnessing on the way some of the horrors of a successful Prussian invasion. He was summoned back to the deathbed of his old chief and friend, Sir Roderick Murchison.

The creation of a school of geology in a poorly endowed University was beset with difficulties; lecture-rooms were inadequate, and rocks and fossils were lacking. The exceptional advantages for field-work offered by the country round Edinburgh were therefore utilised to the full. The field took the place of a lecture-room, and Nature supplied the specimens. In his second year the professor lectured to the Ladies' Educational Association and conducted geological excursions of ladies. Mixed classes, however, were not yet tolerated, and the male students were returned to their homes before the ladies appeared, a mistake in the opinion of the good lady who kept the inn where they stayed. Later, he lectured to the lunatics at the Morningside Asylum, and, by the help of an official, to the inmates of a Deaf and Dumb Institution.

These varied activities were not allowed to interfere with literary work. The third edition of Jukes's "Student's Manual of Geology" was completed by Geikie in 1871; in 1873 two science primers were written, and "The Life of Murchison" was in hand. In the same year, also, obituary notices of two old and valued friends, Logan and Lyell, were gratefully undertaken. At this time, what was perhaps the most onerous task in a busy life began to occupy his mind, namely, the preparation of an advanced text-book of geology. This work, a monument of research, of matured judgments and of lucid statement, was published in 1882. It is interesting to hear that the author of such a work found the writing of the little primers the most difficult task he had ever undertaken. The preparation of a classic memoir on the Old Red Sandstone, and a study of the weathering of marble and other rocks, as evidenced by tombstones, helped to consume what surplus energy was left after the performance of official duties.

An engagement to lecture to the Lowell Institution in Boston in 1879 led to an extended tour in the United States, in the course of which the Yellowstone Park and Salt Lake City were visited. While at Boston, Geikie dined at Lowell's house and sat between Longfellow and Oliver W. Holmes. The poet's face "always beamed with a kindly smile," but to talk to him proved difficult.

In 1882 Geikie succeeded Ramsay as Director-General of the Geological Survey and resigned his Edinburgh professorship. His new duties included supervision of the Scottish and Irish branches, the latter no sinecure, when one member of the staff, still well remembered, was on the warpath. Yet now as ever, time was found for literary work. The text-book was not yet published, and "Geological Sketches at Home and Abroad" was in preparation. At the same time he was prosecuting his studies of British Tertiary volcanic history, the results of which were published by the Royal Society of Edinburgh and were afterwards embodied in "Ancient Volcanoes of Great Britain."

The next few years saw no relaxation in this strenuous life. He was elected foreign secretary of the Royal Society in 1889, but undertook a more onerous task as president of the Geological Society in 1891–92. Presidentship of the British Association followed soon after, and among a shower of press clippings with which the occupant of such a post is bombarded, was one from a phrenological journal to the effect that the "organisation of this gentleman is most favourable for almost any sphere of life." The prophet was on safe ground, for, in addition to the posts already mentioned, Geikie was a member of the Royal Commission on Water Supply and of the Departmental Committee on the Ordnance Survey.

Among much other literary work now in hand was a biography of Sir Andrew Ramsay, the late Director-

General. In lighter vein were the dinners of the Literary Club. At these monthly gatherings Geikie met many distinguished men of letters and retailed the latest good stories from Scotland. The appearance of some of these in *Punch* puzzled him for a time, but he eventually detected the route by which they had travelled. A few years later in "Scottish Reminiscences" he published a selection of (but not all) his experiences of Scottish manners, customs and speech.

A visit was paid to Paris in 1891 to attend the centenary of the Institut de France. The guests were received at an evening function by M. Poincaré, then in his thirty-fifth year. Six years afterwards Geikie received through the French Embassy a beautiful specimen of Sèvres ware, but it was not until some months had elapsed that the unexpected gift was explained. Prof. Fouqué and M. Michel Lévy had moved their Government to accord Geikie the decoration of the Legion of Honour. But the French Ambassador pointed out that the British Government did not approve of the acceptance of foreign decorations by British subjects. The china had therefore been sent as a public mark of esteem, with an expression of keen regret that the British Government should be so exclusive. However, sixteen years later the Cross of the Legion of Honour reached its destination.

The International Geological Congress met every third year before the War, and in 1897 assembled at St. Petersburg. There Geikie was presented with other delegates to the Czar and Czarina and saw a charming phase of Russian home life in the country palace of the Dukes George and Michel of Mecklenburg.

The long period of service upon the Geological Survey was now drawing to a close. In the view of the Treasury, the service itself was of a temporary character and would cease to exist when a geological map of the British Isles on the scale of one inch to the mile had been completed. In such circumstances there had been a tendency to shelve questions relating to promotion, salaries and other matters, about which much dissatisfaction had arisen. This led to a request from the staff for a full inquiry, and eventually to the appointment of a strong committee, on which Government Departments, geological and mining interests were adequately represented. The recommendations made by the Committee were eminently practical and satisfactory. "It was to me," Geikie writes, "a great satisfaction to leave the service with the prospect that these much-needed reforms would be carried out." He retired in 1901 after a service of forty-four years and four months.

Abrupt severance from official duties is apt to leave a man at a loose end, but it was far otherwise with Geikie. Some Survey memoirs were still in hand, and various scientific societies made claims upon his time. Attendance at the first meeting of the International Association of Academies took him to Paris, and at the 450th anniversary of the University of Glasgow he was one of the recipients of the honorary degree of LL.D. In the winter of 1902–3 he attended meetings of the Reale Accademia dei Lincei, of which he was a foreign member, unaware that he was thereby earning a small fee for each attendance. In 1903, at the ninth meeting of the International Geological Congress, in Vienna, he renewed intercourse with his old friend Suess and many others. In this year also he was elected one of the general secretaries of the Royal Society, a post which involves much work in connexion with the numerous activities of the Society. Outside the ordinary routine was the making of arrangements in London for the second meeting of the International Association of Academies. The functions provided for the entertainment of the guests included a garden-party at Windsor Castle, when the members were received by King Edward and Queen Alexandra. The first centenary of the Geological Society was celebrated in 1907. It being felt that the presidential chair should be filled on such an occasion by a geologist of outstanding reputation, Geikie, though he had already been president, was asked to allow himself to be nominated. The celebration led to what was probably as distinguished an assemblage of geologists from all parts of the world as had ever met.

In 1908, on the retirement of Lord Rayleigh, the Council of the Royal Society nominated Geikie as his successor to the presidential chair. The many duties which are attached to the post, both within the Society's rooms and outside, made serious inroads upon his time, but gave him the opportunity of devoting his energies more strenuously than ever to the welfare of the Society. The most outstanding incident during his presidentship was the celebration of the 250th anniversary in 1912. Men distinguished in every branch of science attended from all parts of the world. After a short service in Westminster Abbey, the delegates handed the addresses with which they had been entrusted to the president in the Society's Library. In the evening a banquet was held in the Guildhall, at which the toast of the Royal Society was given by the Prime Minister and responded to by the president. An unpremeditated toast was added to the list during dinner, that of Prince Lichnowsky, the newly appointed German Ambassador. In his reply he said, "Never between England and Germany have there been more intimate and more sincere relations than at present. Both countries are working side by side in the same cause of maintaining European peace." It appears to have been a fact that the preparations for the War, then

being made by the higher powers in Germany, were not known to the German Ambassador. Two notable volumes were prepared at Geikie's instance in readiness for the celebration; one an enlarged edition of the Society's "Record," the other a facsimile reproduction of the Charter Book containing the original signature of Charles II., followed by the signatures of all fellows from the commencement, "a collection of autographs probably without an equal, as representative of the science and culture of Europe during the period which it embraces."

At this time the British Academy came into existence and was soon followed by the Classical Association. As president of the latter Geikie chose for the subject of his address the evidence in Latin literature of an appreciation of Nature by the Romans. The subject proved so fascinating that he pursued it later on both at home and amidst landscapes that must have been familiar to some of the Roman poets. The writing of the book, "The Love of Nature among the Romans," served, so far as anything could, to distract his thoughts from the tragedy of the death of his only son, a young man of brilliant promise.

From 1914 Geikie's time has been spent chiefly at his country home near Haslemere, and though not so active as he once was, there has been little relaxation in his industry. In 1920 he was elected as chairman of the Royal Commission of Inquiry into the University of Dublin. "The Annals of the Royal Society Club" was written during these years of retirement, and now has been followed by the fascinating volume to which this notice relates. It was during this period of quiet retreat, on the last day of 1913, that a special messenger brought the intimation that the King had conferred upon Geikie the Order of Merit. He had already been made K.C.B. in 1907. Space does not admit of the enumeration of the academic honours conferred upon him.

I cannot conclude more fittingly than in the words used by Walter H. Page, at the time American Ambassador. In a letter to Geikie on his birthday, which he had learnt was the same day as that of the President of the United States, he wrote, "You also are entitled to great thanks for being born into a world that you have made wiser and merrier by your presence and labour."

A. STRAHAN.

A Biological Study of Radiation.

Radium, X-rays and the Living Cell: with Physical Introduction. By Hector A. Colwell and Prof. Sidney Russ. Second edition, revised. Pp. xi+365 +3 plates. (London: G. Bell and Sons, Ltd., 1924.) 21*s*. net.

THE second edition of this book, which was first published nine years ago, brings the experimental biological study of the effects of radiations up-to-date; it includes a new chapter which summarises the action of rays on living structures, and discusses the theories put forward to explain these actions.

The authors are, rightly, cautious in discussing "Laws." Their subject is a new one, and it is only recently that the nature of X- and gamma rays has been settled and their place in the electromagnetic spectrum charted.

How do X-ray exposures cure tuberculous glands? By killing the tubercle bacilli? In a test-tube, X-rays can kill tubercle bacilli, but it takes a big dose—so big that no human tissues could live through the bombardment. How then does a moderate dose cure the patient? Clearly it is the human body that achieves the cure; the tissues react to the radiation, and kill and rid themselves of the intruding bacilli, weakened by the radiation. Many factors may be at work. The action of the X-rays may be selective, weakening the bacilli but weakening the tissue cells less, or actually stimulating the tissue cells to increased activity.

Clearly there are countless problems for experimental solution. The conclusions so far reached are valuable, but (as the authors point out) they are still very incomplete, inconclusive, and even contradictory.

Of chief interest is the bearing of these researches on the treatment of cancerous growth. Stated briefly the conclusions are: Some growths can be abolished and an apparent cure obtained. Others can be reduced in size, with temporary relief, only to take on new activity which defies control by radiation. Even the "cures" are only too commonly illusory. The disease breaks out again in the same place or elsewhere and becomes disseminated. We seem to be no nearer the "cure" for cancer. But we need not despair, nay, we dare not. Although a cure may never be found, there is great hope of our learning how to prevent cancer. We are now certain that cancer is not a disease which springs upon us mysteriously, and strikes us down "like a bolt from the blue." It is the last phase of a chronic disease that affects our tissues, makes them unsound, and deprives them of their powers of resistance.

Certain races live a natural life in the open air, engaged in active agricultural pursuits, and eating the natural "live" foods of Nature (grains, nuts, milk, eggs, fruits, and uncooked vegetables). These races are immune from the disorders of digestion so rife in civilised lands. They do not suffer from dyspepsia, gastric and duodenal ulcer, gall stones, appendicitis and colitis, and they live to a good age without falling victims to cancer. Contrast their state with that of dwellers in civilised towns. Their life is largely indoors and sedentary, their food and drink almost entirely "dead" food; it is frozen for long periods, or boiled and canned, or impregnated with chemicals, such as

borax, sodium salicylate, and saltpetre. Even the fresh foods that reach the consumer un-killed and undefiled, pass through the kitchen, and are there deprived of their living properties, and worked up into appetising dishes. "Hunger is the best sauce," but the life that is forced upon civilised races deprives them of this relish. To make matters worse, sugar (sweetmeats and chocolates) are eaten in great quantity. The consequence is that the digestive system fails; constipation and intestinal stagnation occur; the over-filled stomach and intestines drop and become kinked; their stagnant contents decompose and poison the system. Not only the stomach and intestines, but also every tissue of the body is poisoned and loses its power of resistance. Sooner or later a stage is reached when some part gives way, when we have another case of gastric ulcer or appendicitis, and the surgeon is called in to remove the part that has "rotted." If the surgeon is an observer, he notices that the rot is general and is not confined to the appendix, gall bladder, or gastric ulcer which he is removing.

A person whose tissues are in this state is certainly on the road to cancer, and little lasting good can come of an attempt to cure him by local radiation. He must "clean himself up"; then Nature will have a chance to aid him in his fight for life. The great good that may come from the experimental researches described in this book is that it may teach us Nature's method of ridding itself of morbid growths. The new edition is of immense interest to all who are engaged in the study of tumour growth.

Our Bookshelf.

A Practical Handbook of British Birds. Edited by H. F. Witherby. 2 vols. Vol. 1. Pp. 532+xvi. Vol. 2. Pp. 960+xii. (London: H. F. and G. Witherby, 1919–1924.) 4*l.* 10*s.* net.

THIS important work, which has been appearing in parts since 1919, is now complete, and the corrections and additions in the last part bring the whole up-to-date. The bound book is available in alternative forms, and of these the thin paper edition makes two volumes of little more than pocket size. It is thus a handbook in a real sense, but at the same time the quality of its contents fully entitles it to a worthy place on the library shelf with larger works of reference.

The object aimed at has been to give in a small space and in systematic form all the most important information about the external characters of British birds, their distribution and migration, their breeding habits, nests and eggs, their song and their food. This has been very successfully achieved by the authors responsible for the various subjects. The numerous illustrations, many of them in colour, are admirable from the point of view of practical utility as aids to identification. There are also useful key tables to the distinguishing characters of the different systematic groups.

The book is, however, more than a carefully compiled and well edited work of reference. It represents, indeed, much original investigation, the results of which are presented for the first time. This refers particularly to the descriptions of plumage, most of them by the editor himself, which constitute the most important part of the work. These descriptions have been based upon new examinations of large series of specimens, including those in the British Museum and in Lord Rothschild's large collection, and they take full account of all differences of sex and age and of all seasonal changes: the different geographical races or sub-species are separately treated. The method is consistently followed in this respect, and in a few cases, from their nature unimportant in British ornithology, a phase is frankly mentioned as "not examined." A great labour has obviously been performed, and as a result we have much valuable information not previously available, and a high trustworthy standard throughout.

The treatment of the other subjects is less detailed but quite adequate for the purpose, the limits observed being those proper to a condensed work of reference. The contributors, other than the editor, are Dr. Ernst Hartert, Miss A. C. Jackson (Mrs. Meinertzhagen), the Rev. F. C. R. Jourdain, Mr. C. Oldham, and Dr. N. F. Ticehurst.

This "Practical Handbook," then, in addition to containing important new contributions to ornithology, seems to us to be the most useful systematic text-book of British birds that can be placed in the hands of the serious student of the subject. It undoubtedly takes its place as a standard work.

The Year-Book of the Scientific and Learned Societies of Great Britain and Ireland: a Record of the Work done in Science, Literature, and Art during the Session 1922–1923 by numerous Societies and Government Institutions. Compiled from Official Sources. Fortieth Annual Issue. Pp. vii+389. (London: C. Griffin and Co., Ltd., 1923.) 15*s.* net.

WE are glad to be able to extend a welcome once more to this valuable handbook, which has now reached its fortieth anniversary. The publishers are to be congratulated on the courage and persistence with which they have issued year by year a volume so useful to all who would keep in touch with scientific developments and at the same time a book necessarily of limited circulation. The volume is divided into the customary fourteen sections, in each of which related societies are grouped. The classification this implies is a difficult problem, but we have little fault to find with the present arrangement; the Institute of Physics would appear more appropriately in the section given to astronomy, mathematics, and physics than in its present place under "Science Generally." The very full index, however, will generally obviate any difficulty which may arise in this way.

For those who are not familiar with the handbook, it is desirable to say that it gives full particulars of the scientific and learned societies of the British Isles, their officers, addresses, meetings, conditions of membership, publications, and, in many cases, the titles of the papers presented and lectures during the year

1922–23. There are also included accounts from Government institutions, such as the National Physical Laboratory, the Royal Observatory, Greenwich, and so on. In some few entries, telephone numbers and telegraphic addresses are also given; this might usefully be extended to all the societies which are served by telephone. We also think that a complete list of the various Research Associations, together with separate entries in their appropriate sections, would be valuable, while other omissions we have noted are the Institution of Chemical Engineers, the Eugenics Education Society, and the Institution of Welding Engineers.

The information provided by the handbook is furnished by officials of the societies concerned, and we must add our thanks to those of the publishers for making the volume possible. No doubt it is by a slip that the new address of the Institution of Automobile Engineers from August last has not been inserted.

Our criticism must not be taken as disparaging. In no other volume, we believe, is similar information brought together, and our suggestions are made in order that the next issue may give us cause for still more gratitude to the publishers and all concerned in issuing the handbook.

Canned Foods in Relation to Health. (Milroy Lectures, 1923.) By Dr. William G. Savage. (Cambridge Public Health Series.) Pp. vii+146. (Cambridge: At the University Press, 1923.) 8*s.* 6*d.* net.

THIS book consists of the author's "Milroy Lectures," delivered in 1923, with some amplification. The canning industry is a very important one in the United States and South America, and in the overseas Dominions. Though the industry is small in Great Britain, large quantities of canned foods are imported and consumed here. Thus in 1921 some 22,500 tons of canned meat alone (and much larger quantities of salmon and fruit) were retained in Great Britain.

Apart from the magnitude of the industry, there are special reasons why this class of food-stuffs needs supervision additional to that exercised over food generally. The most important of these is that the use of unsound constituents is less easily detectable than in the case of ordinary foods. Dr. Savage has examined various methods of manufacture, and pays a high tribute to the work done by the National Canners' Association (U.S.A.) in the improvement of the products of its members. But he finds that the control exercised over canned foods at the port of entry leaves much to be desired, and that better and more uniform methods are required for the disposal of the contents of rejected tins. Dr. Savage also urges that the date of preparation, together with a code mark for identification, should be stamped on all tins. The important subject of the causation of disease by canned foods is dealt with at length by Dr. Savage, and he comes to the comforting conclusion that canned foods as a whole are safer than fresh foods.

The book contains a very complete summary of this important subject, and concludes with appendices on the principles involved in the process of canning, and on the laboratory methods for the examination of canned foods, and with a selected bibliography of the subject.

Invertebrate Zoology. By Prof. Harley Jones van Cleave. (McGraw-Hill Agricultural and Biological Publications.) Pp. xvi+259. (London: McGraw-Hill Publishing Co., Ltd., 1924.) 15*s.* net.

IN this volume the author "has endeavoured to collate materials which will serve as a class-room text and reference work," assuming that the student has already had an introductory course in zoology. The attempt to compress an account of the invertebrates into 240 pages is, in our opinion, scarcely successful, for it has compelled the author to deal so summarily with many of the subjects and of the classes that the accounts are too short and inadequate to be of real value; *e.g.*, endomixis is dealt with in about eight lines, and the student can form little idea of the process from a perusal of this brief statement. It would have been better, we think, to omit reference to a number of the more difficult groups, *e.g.*, Phoronida (the account of which occupies about eight lines), and deal more fully with other groups. Some of the references to protozoa require revision, *e.g.*, that *Piroplasma hominis* is the causal agent of Rocky Mountain fever, and the use of "hæmogregarines" as synonymous with Babesia is incorrect. If a cyst of *E. histolytica* is to be illustrated at all, a figure better than Fig. 24 should have been provided. We can only conclude that in a course in which such a compressed account of invertebrates is used, it is intended that much of the information on any given group will be acquired in the laboratory, the text-book serving as a brief summary for reference.

The Diseases of the Breast. By Willmott H. Evans. Pp. xii+495+102 plates. (London: The University of London Press, Ltd., 1923.) 27*s.* 6*d.* net.

THE subject of diseases of the breast is one which presents many problems to the clinician, the pathologist, and the surgeon. Mr. Willmott Evans endeavours to sum up the present views on the subject, and draws on his own experience to express opinions on controversial points. His book is certainly very complete, covering anatomy, physiology, clinical examination, pathology, and treatment down to the last detail. With regard to the disputed subject of dissemination of carcinoma, Mr. Evans has no hesitation in accepting the theory of permeation described by Sampson Handley, with the reservation that embolism may account for a certain number of metastases. The book is well produced and well illustrated; it forms an excellent addition to the literature on diseases of the breast.

Statique et résistance des matériaux. Par Prof. Paul Montel. Pp. vi+274. (Paris: Gauthier-Villars et Cie, 1924.) 30 francs.

THIS book is practically a reproduction of the lectures delivered at the École des Beaux Arts by Prof. Montel on statics and the resistance of materials. The range does not differ essentially from that covered by English text-books, but to those who have a penchant for geometric in preference to analytical proofs, the book is to be recommended. Wherever possible geometrical demonstrations are adopted and numerical calculations effected graphically. A number of useful practical examples are to be found at the end of each chapter.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Anomalous Emission of α-Particles from Polonium.

IN a recent issue of the *Zeitschrift fur Physik*, Walther Kutzner has given the results of some careful measurements made with the view of testing the validity of Bateman's probability formula in its application to the emission of α-particles by polonium (*Vide Zeit f. Phys.*, vol. 21, pp 281–298, 1924). He arrives at the following conclusions :

(1) The emission of α-particles by polonium does *not always* obey Bateman's probability formula for a process of a purely fortuitous nature

(2) Systematic deviations have been found to indicate a *subnormal* dispersion, *i.e.* the time intervals in which definite numbers of particles are observed occur more frequently, when the numbers lie near the mean value, than would be expected by the laws of probability. On the other hand, the time intervals corresponding to a large or to a small number of particles occur less frequently than theory predicts. (In other words, the familiar "cocked-hat" probability curve is higher at the crown and lower at the brim than would be expected from the theory)

(3) It is found that the deviations are more appreciable, the greater the activity per mm.^{2} of the radioactive source.

(4) By allowing the source to decay, an improvement is found in the agreement between theory and experiment.

(5) The cause of this behaviour with polonium is discussed, and it is shown that, although the phenomena of scattering, surface oxidation, and diffusion of the polonium into the activated discs can influence the magnitude of the "subnormal dispersion," they are in themselves insufficient to explain the phenomenon mentioned in (4).

(6) For the explanation of this result it is suggested either that the individual radioactive polonium atoms mutually influence each other, or that the individual α-particles influence other atoms (atomic disruption).

From simple considerations one would not expect that an α-particle could approach the nucleus of a heavy atom sufficiently closely to bring about artificial disintegration, and hence it becomes imperative to examine whether Kutzner's results can be explained in a less drastic manner than that suggested under (6) above. The object of the present note is to show that effects identical with those observed by Kutzner are to be expected on the basis of the phenomenon of aggregate recoil, as usually obtained from sources of α-rays deposited on metallic discs The importance of this phenomenon in the case of polonium was fully discussed in a paper by the present writer in 1919 (*Mitt. Ra. Inst.* Nr. 118, *Wien. Ber.*, vol. 128, pp. 795–830 ; also NATURE, vol. 102, p. 464, 1919), and has been confirmed by additional unpublished results, of which use will be made in what follows.

Electrolytic polonium does not consist solely of individual atoms on the metal disc, but an appreciable part of the deposit may exist in the form of aggregates of polonium atoms. Such aggregates are also formed in the case of the active deposit obtained by exposing a metal plate in emanation. When an α-particle is emitted in the direction of the plate from such an aggregate, the latter recoils from the plate, and in a vacuum leaves it entirely. Under such conditions one instance was noted in which the apparent decay of polonium was such as would correspond to a half period of 59·6 days, as compared with the true half period of 136·5 days But even at ordinary pressures the rate of decay sometimes appeared to be so low as 127·1 days, so that even under normal conditions some of the recoiled aggregates may disappear from the plate. The number of aggregates per unit area and their complexity increase with the surface density of the electrolytic deposit, and, particularly under reduced pressures, it is the more complex groups that leave the plate first, in consequence of their containing more polonium atoms. In the course of time it follows that the polonium remaining on the disc is less and less complex, and indeed, after a sufficiently long time, one would expect the polonium remaining to consist almost entirely of individual atoms. As a matter of fact, aggregate recoil phenomena do become less marked with the lapse of time, owing to the degeneration of the aggregates, and many curious effects observed with radioactive deposits admit of simple interpretation on these lines (*e.g.* observations by Ratner, *Phil. Mag.* (6), vol 36, p. 397, 1918).

Owing to the intense ionisation near the surface of a disc coated with polonium, it is easily seen that the aggregates, after recoil, may readily acquire a charge, and in circumstances negatively charged aggregates may preponderate.

Consideration of the above results supplies us with a ready interpretation of Kutzner's observations, for he used an electric counter of the Geiger type, in which a platinum point is enclosed in an outer metal cylinder or hemisphere, charged to a positive potential of more than 1000 volts, there being a small central opening in the front of the counter, covered with thin aluminium foil, through which the α-particles are admitted. In general, the distance of the radioactive source from the counter diaphragm, with respect to which it was centrally arranged, was from 5 to 7 mm., so that the intervening space would be subject to a strong electric field From what has been said above, it is clear that many of the recoiled aggregates would be attracted to the aluminium foil closing the counter, so that the counts corresponding to the maximum of the probability curve would lie too high, whereas the limiting ordinates observed would be deficient. This is precisely what Kutzner noted (see (2) above). Moreover, since the formation of aggregates is enhanced for higher surface densities of the radioactive deposit, the deviations will be more marked in such cases (cf. (3) above). On the other hand, by allowing the polonium to decay, a progressive degeneration of the aggregates takes place, and the deposit acts more and more nearly like one composed of individual atoms, so that the agreement between experiment and theory improves steadily (cf. (4) above).

Using preparations of polonium of high surface density, Kutzner found, for a given source, that the deviations from theory were more considerable, the larger the aluminium-covered diaphragm through which the α-particles entered the counter. The number of transferred aggregates that are effective will obviously depend on the size of the diaphragm, being greater for larger diaphragms, so that such a result is to be expected, whereas it would be much smaller, or almost absent, when the same experiments were performed with a preparation of low surface density, and this Kutzner found to be the case.

By performing counts in which the source was first centrally opposite the entrance to the counter, and secondly, laterally displaced through 5 mm. with respect to the axis of the counter, Kutzner detected

a better agreement with theory in the latter case. This he ascribes to an influence of the direction of the α-particle beam within the counter, but it seems more likely that it was due to the fact that, in the second case, a smaller proportion of the transferred aggregates fell on the counter window In another experiment, Kutzner found that with an unscreened source the deviations from theory were less than when the source was screened by a thin aluminium foil. This result may be, as he suggests, connected with the effects of scattering, but if the experiment were performed in the reverse order, one would expect that the screened source would give better agreement with theory than the unscreened.

Finally, Kutzner finds that counts with a willemite screen always yield results about 5 per cent. less than with an electric counter (*loc. cit.*, also *Zeit. f. Phys.*, vol. 23, p 126, 1924). In view of the above, it is doubtful whether the whole of this difference is due to the inefficiency of willemite screens as compared with electrical counters, though it is generally recognised that deficient counts result from the scintillation method. It seems very probable that thin sections of willemite, as used by Kutzner, are more efficient than scintillation screens made from powdered willemite or zinc sulphide crystals. Were Bateman's formula to be tested by means of such screens, one would expect better agreement between experiment and theory than Kutzner found by means of the electrical counter, owing to the absence of an impressed electric field in the former case.

The deviations from theory in experiments by Rutherford and Geiger and by Hess and Lawson, to which Kutzner refers in his paper, are less systematic than his own. The former (with polonium) probably admit of the above explanation, whereas the latter were done with γ-rays and only for purposes of orientation. ROBERT W. LAWSON.

Sheffield.

The Rotatory Dispersion of Tartaric Acid.

LONGCHAMBON (*C.R. Acad. Sc.*, vol. 178, p. 951, 1924) has recently found that the rotatory dispersion along the optic axes of crystalline tartaric acid is approximately the same as that of the lævo-rotatory component which contributes to the anomalous rotatory dispersion shown by solutions of the acid. The rotatory dispersion here referred to is measured by the ratio between the rotations for the blue (436 μμ) and yellow (578 μμ) lines of mercury. For the crystals it is 2·14, while for the lævo-component in solution it is estimated to lie between 2 and 2·22. From previous researches Longchambon had concluded that the rotatory dispersion of a given substance is a property which is conserved when the substance passes from the solid to the liquid state by fusion or solution. Applying now this generalisation to the case of tartaric acid, he states · " Le constituant gauche ne serait donc ni un anhydride ni un éther interne ; ce serait l'acide tartrique ordinaire, *tel qu'il se trouve dans le cristal*; je l'appelerai ' acide tartrique α.' J'appelerai le corps droit ' acide tartrique β '; c'est la formation de cet acide β de l'acide α, par dilution ou élévation de température, qui produit les anomalies de dispersion rotatoire."

It seems appropriate now to compare these conclusions with those arrived at from the X-ray examination of the crystal structure of tartaric acid (Proc. Roy. Soc. A, vol. 102, p. 506, 1923). Out of this work it was suggested that the dextro-rotatory property of ordinary tartaric acid is associated with the carbon nucleus of the molecule, an arrangement of four carbon atoms which appears to exist in the crystal as an irregular tetrahedron, while the lævo-rotatory power is associated with the rest of the molecule, manifesting itself principally through a twisted arrangement of the four hydroxyl groups, similar, but longer than and in an opposite sense, to the twisted arrangement of carbon atoms " There is only one part of the molecule to which we can ascribe any degree of stability, and that is the nucleus of four carbon atoms arranged in an irregular spiral. Such effects as ionisation and hydration would tend to destroy the lævo-rotatory action of the four hydroxyl groups, *and it is probable that it requires the application of the forces which bind the molecules into the crystalline structure to complete the lævo-rotatory system.* Any change, such as fusion, solution, and certain chemical reactions, which leads to departure from the orientations which hold in the crystalline structure will tend to eliminate the hydroxyl spirals " (p. 527)

It thus appears that the work of Longchambon supports the conclusion arrived at from the X-ray analysis, that the lævo-rotatory component in solution is substantially the same system as that which produces the strong lævo-rotation in the crystalline form, that the tendency to crystallise and the act of crystallisation, though not unique as changes involving forces which enhance the lævo-rotatory power, are yet well-marked examples of such changes and lead finally, in the crystalline form, to the perfection and stabilisation of a lævo-rotatory system which completely overpowers the effect of the dextro-rotatory part of the molecule. From such a hypothesis it follows that, even in infinitely dilute solutions, since the molecule can never be stripped bare to the carbon nucleus above, the rotatory dispersion will still be anomalous. That this is experimentally true has been pointed out by Lowry and Austin (*C.R. Acad. Sc.*, vol. 178, p. 1902, 1924) in reply to the note of Longchambon. It also follows that the dispersion in the crystal, though the lævo-rotation overwhelmingly predominates, is probably not truly normal either. It is true that Longchambon says " la dispersion rotatoire est d'allure normale, mais très forte, . . ." but I presume this remark refers only to the region of the spectrum examined.

W T. ASTBURY.

Davy-Faraday Research Laboratory,
Royal Institution,
Albemarle St., W.1, July 7.

Early Canadian Experiments on the Acoustic Method of Depth Sounding for Navigation Purposes.

REFERRING to the article " The Acoustic Method of Depth Sounding for Navigation Purposes " published in NATURE of March 29, 1924, p. 463, it may be of interest to record some experiments carried out by the writer in 1915 on obtaining depths at sea by the echo method.

Having had much experience in carrying on fog alarm researches at Father Point, Que., for several years from 1913, the writer felt in the early days of the War that this site would be an admirable one for carrying out researches on submarine acoustics, with the view of solving some of the problems relating to the submarine situation in Europe. In addition to the facilities for experimental work, such as isolation, wharfage facilities, calm weather, easy access to a main railway line, etc, an important consideration was the fact that supplies of scientific material from America and co-operation with American men of science could be obtained on Canadian territory before the United States had yet entered the War.

In the early autumn of 1915 a plan and report to this effect was sent to the Minister of Marine and

Fisheries; and, while the question was being considered by the Canadian Government, a start at actual research was made with the co-operation of the Submarine Signal Company of Boston, Mass., U.S.A. It was decided to repeat the experiments of Prof. R. A. Fessenden (Trans. Am. Inst. of Elect. Eng., vol. 33, Oct. 1914, pp. 1569-1581) "On Obtaining the Depth of the Sea by the Echo Method." A Fessenden oscillator with the associated motor generator set was installed on the Canadian hydrographic survey ship *Cartier*, and during the month of October 1915, numerous experiments were tried on "depth sounding" (Fig. 1). A short experience showed that for moderate depths, 30 to 40 fathoms, the same oscillator could not be used for receiving the echo, on account of the persistence of transients in the electromagnetic circuits. A separate hydrophone, shielded from the oscillator signal by being placed on the opposite side of the ship, was therefore employed, and experiments, though for the most part unsuccessful on account of the weak echoes received from a sea bottom of soft ooze and clay, gave indications at favourable localities as to the ultimate possibilities of this method.

At this early date and under war conditions, it was practically impossible to obtain thermionic amplifiers

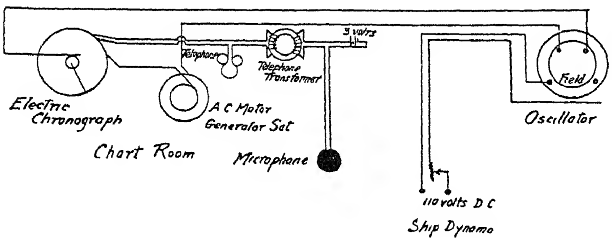


FIG. 1.

by means of which echo signals could be received. Then, too, for the faint echoes involved, the type of hydrophone available was not sufficiently sensitive, while for experimental work the type of oscillator available, weighing 1300 lb., was inconvenient for overboard use, especially with the ship in motion.

In a report submitted to the Electrical and Submarine Committee of the Admiralty Inventions Board, it was finally concluded that special transmitters of less weight, designed for inboard use, would have to be developed in conjunction with a more sensitive type of hydrophone. In order to obviate the use of thermionic amplifiers as much as possible, it was decided to make use of a hydrophone, suitably damped, capable of tuning in to the definite wave-length emitted.

A tuneable diaphragm, forming an essential feature of a hydrophone, was briefly described in the Proc. Roy. Soc., London (99-A, 1912, pp. 163-171). At the request of the Inventions Board the complete mathematical theory of electrically operated sound generator was undertaken, with the view of facilitating design.

It will be readily seen that a diaphragm both for emitting and receiving corresponds to the aerial in radio-telegraphy. In the latter field, the enormous advantage of the aerial tuning condenser for the selection of narrow wave-length bands is the characteristic feature of modern radio transmission and reception, an enormous increase in the range of communication having thus been effected. In just the same way, the writer anticipates a radical improvement in the art of submarine signalling by the introduction of tuneable diaphragms enabling specified wave-lengths to be picked up to the exclusion of others.

During the past few years the writer has been working at improvements in the construction of transmitters and receivers based on the principle of selective tuning, which it is hoped may find a useful field of application in an improved system of depth sounding for navigation purposes.

LOUIS V. KING.

McGill University, June 15.

Study of Explosions.

SIR OLIVER LODGE, in NATURE of July 5, p. 10, suggests that the methods of producing the "Big Bangs," which have previously been used, may not be the most effective for the purpose.

While on service in France with the Artillery, it appeared evident to me that the noises with the greatest "carrying power" were made by the gun discharges, and not by detonations of high explosive shells.

The battery with which I was at the time was a 6-in. howitzer battery, and I noticed that the detonations of our own shells, although visually observed from an O.P. at 2000 or 3000 yards range, were often inaudible; whereas an enemy gun or howitzer at the same order of distance was always distinctly heard.

The noise of the great bombardment near Ypres in 1917, which was clearly heard from the South Downs in England, always seemed to me to be that due to the guns themselves, and quite unlike the characteristic "c-r-r-rumps" of H.E. shell detonations.

It seems possible that the detonation of a high explosive must produce an air wave of a very steep wave front, which may be damped out by the internal friction of the air particles more rapidly than the slower rise and fall of pressure produced by the combustion of the propellent type of explosive.

It is to be hoped that Sir Oliver Lodge's suggestion that in a future trial a charge of gunpowder or cordite should be exploded, in some form of container if necessary, at a considerable height from the ground, will be adopted.

P. J. RYLE.

Hadley House, Pangbourne,
Berkshire.

IN view of the recent attempts to utilize surplus munitions of war in the investigation of the propagation of sound in the atmosphere, it may be worth while to direct attention once more to the opportunity that explosions afford for investigating the propagation of seismic waves in the upper layers of the earth's crust. In the Oppau explosion 4000 tons of explosive produced a wave that was recorded by a seismograph at a distance of 365 km. This was a surface explosion. The momenta communicated to the air and the earth by the shock must have been equal, and therefore the amounts of energy that went into the air and the earth must have been in the ratio of the velocities; thus much less than a thousandth of the energy can have gone into the seismic wave. If, however, the explosive is buried deep in the ground, nearly all the energy will go into the earth. Thus a wave of intensity greater than that produced by the Oppau explosion could be produced by firing 4 tons of explosive underground. Further, timing could be made specially easy by having the explosion in wireless communication with the observatories, thus eliminating the uncertainty of the time at the focus.

HAROLD JEFFREYS.

St. John's College, Cambridge.

Different Types of Ions in Hydrogen.

IN a previous letter (NATURE, June 16, 1923, p. 810), and more recently in the Proceedings of the Royal Society (105, p. 116, 1924), I described some experiments on the products of ionisation in hydrogen, nitrogen, and oxygen. It may be recalled that the method depended on the combination of an ordinary ionising potential arrangement with a simple positive ray analysis apparatus.

For hydrogen the principal conclusion drawn was that ionisation at 16·5 volts was not accompanied by dissociation. This conclusion rested on results at very low pressures where no atomic ions were detected below twenty volts and comparatively few even up to the highest voltages used. It was found, however, that at higher pressures the relative intensity of the atomic ions, H^+, became much greater, apparently due to a secondary dissociation of the molecular ions, H_2^+. No appreciable number of triatomic ions, H_3^+, had been observed at low pressures, and no search was made for them in the few experiments made at high pressures

I have now set up an entirely new apparatus very nearly identical with that used in Cambridge and wish to report further results. The conclusion that the primary product of ionisation in the neighbourhood of 17 volts is H_2^+ has been confirmed. However, as the pressure is increased, it is found that H^+ does not necessarily become dominant. The effect due to H_2^+ becomes smaller and both H^+ and H_3^+ increase in intensity, but their relative size depends on the arrangement of the electrical fields (to be specific, on the strength of the field designated V_2 in previous communications). Thus, by varying conditions of pressure and electric field it is possible to produce almost any desired proportions of the three types of positive hydrogen ion.

The new evidence on a possible critical potential at about 20·8 volts corresponding to ionisation accompanied by dissociation is not conclusive, but makes its reality very doubtful.

The most interesting new result I have to report is, perhaps, the observation of peaks corresponding to apparent values of $m/e = 1/2$ and $1/3$. These are not attributed to anything so unexpected as doubly and trebly charged hydrogen nuclei, but merely to ions which have fallen through the entire electric field as H_2^+ or H_3^+, but which break up in the field-free space between the two slits before passing into the magnetic field. It is nevertheless remarkable that the atomic ions so formed should retain the direction and velocity of the original ions sufficiently to pass on through the magnetic field and produce a "peak." Obviously these results suggest a reinterpretation of the effects in nitrogen and oxygen previously attributed to doubly charged atoms. They also offer interesting possibilities for studying the mechanism of ionisation.

These points and others will be taken up in a full report of the work which I hope to write in a few months. H. D. SMYTH.

Palmer Physical Laboratory,
Princeton University,
Princeton, New Jersey, June 4.

Transplantation of Heads of Insects.

IT may be of some interest to biologists if I supplement Dr. W. T. Calman's letter under the title of "Chimæras Dire" (NATURE, July 5, p. 11) by a brief record of some experiments of my own. Not having any water-beetles available at the time, I tried to repeat Dr. Finkler's experiments on meal-worms. I cut off the heads of two pairs of specimens, and interchanged those of each pair. In a third case I had a single specimen which had recently moulted, and after removing its head put in its place that of another individual. The heads became attached to the alien bodies. I kept the specimens in Petri jars with a little meal. They made no spontaneous movements, but showed signs of life for a varying number of days, the maximum number being five The signs of life in question were response to stimulation of the body with a blunt point. The head seemed to be dead long before the body. The only remarkable thing in the result of these experiments was the tenacity of life of the insect body after decapitation, and it may be doubted, especially after the results of Drs. Blunck and Speyer, whether anything more occurred in Dr. Finkler's experiments. J. T. CUNNINGHAM.

21 Gower Street, W.C.1.

Velella at Port Erin.

WE have just found enormous numbers of the remarkable Siphonophore *Velella spirans* cast up by the tide in a neighbouring bay (Perwick). My daughter and a friend first noticed some specimens floating in a shore pool, and then we found abundance amongst the wet sea-weed at high tide mark, and picked up several hundreds in a few minutes. They were all dead, but many still showed the polypes and tentacles and the beautiful violet coloration.

This is not actually a new record for the Irish Sea, though a very rare event. A similar case was recorded, I think, in the first volume of the L.M.B C. "Fauna of Liverpool Bay" many years ago, and probably indicates an exceptionally marked inflow of Atlantic water. Those who are now studying the variations in the movements of the currents and the plankton in British Seas may be interested to hear of this unusual occurrence. W. A. HERDMAN.

Port Erin, July 13.

A Rare British Oligochaet.

IN Mr. Beddard's Monograph of the Oligochæta, p. 216, reference is made to *Rhynchelmis limosella* Hoffm., in these words: "There is every probability that it is a native of this country." I reported the finding of a specimen some years ago at Ringwood, but there was an element of doubt. Now, however, I am in receipt of an excellent specimen sent me by Mr. W. J. Lucas, which puts the matter beyond all question. Mr. Beddard thinks there is a specimen in the Oxford Museum, but I have had no confirmation of this. HILDERIC FRIEND.

"Cathay," Solihull.

Physical Properties of Clay.

THE late Dr. R. Mullineux Walmsley was interesting himself in my work on the above subject, and for this purpose I lent to him my own special set of my five papers on the subject which were read before the Society of Engineers in the five years 1919–1923 inclusive. Unfortunately, this set has not been found among Dr Walmsley's papers either at the University of London, the Northampton Polytechnic, or at his private house, and, knowing how careful he was, this points to his having probably lent the papers to somebody in connexion with the matter with which he was dealing As the sets of these five papers are now so scarce, and especially as the set in question was my own private set, if this letter meet the eye of the person to whom the set was lent, I shall be greatly obliged if he will be so good as to return it to me. A. S. E ACKERMANN.

17 Victoria Street, S.W.1.

Colours, Stains, and Dyes.[1]

By Prof. J. F. THORPE, F.R.S.

THE great majority of chemical substances occurring either as natural products or as the outcome of synthetic preparations in the laboratory are colourless. In other words, white light reflected from their surfaces or transmitted through these solutions is unaffected so far as its balanced colours are concerned and emerges unaltered. The absorption of light in these cases is general; that is, it takes place equally throughout the visible range of the spectrum and the object, therefore appears colourless.

On the other hand, there are a number of substances which possess the property of absorbing certain portions of the visible spectrum while reflecting or transmitting the remainder. These substances, therefore, appear to the eye to be coloured in accordance with the portion of the spectrum transmitted or reflected. A red substance is one which absorbs the blue region of the spectrum; a blue substance one which absorbs the red region, and so forth. This is known as selective absorption. Again, there are a number of substances, chiefly members of the carbon family, which have the power of absorbing rays outside the visible region of the spectrum—for example, in the infra-red or the ultra-violet—and these substances, since they possess selective absorption, must be regarded as coloured in a chemical sense, although the "colour" they transmit or absorb is not visible to the eye.

The hydrocarbon benzene is an example of the type of chemically coloured substance, and, as we shall find later, this property possessed by benzene causes it to be the parent substance of those very numerous and industrially important materials—the coal-tar dyes.

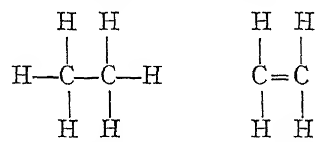
It is not in its lack of power to detect the ultra-violet range alone that the eye fails as an organ of vision, because even in the visible region its power to detect the end colours is seriously restricted. It is most sensitive towards green and red.

The power of a chemical substance to produce selective absorption is without doubt due to its chemical structure; that is to say, white light is "filtered" through the molecular structure of the substance, leaving a "portion" behind in its passage. The colour is therefore dependent on the chemical composition of the particular compound. On the other hand, it is possible to produce visible colour by entirely physical or mechanical means, as, for example, by ruling a number of fine lines on glass, and in these cases colour is independent of chemical structure, being entirely physical in character.

Nature, in producing the variety of coloured substances around us, has adopted both the physical and chemical methods to achieve her ends. The colour of flowers and leaves has been brought about by the use of coloured chemical substances, and these I shall deal with later. But many of the colour effects produced in the wings and feathers of birds and in butterflies are not due to the presence of any coloured substance in them, but to the arrangement of fine filaments or hairs, which serve the purpose of disintegrating white light and reflecting the desired shade of colour. The best test for this kind of colour effect is to examine the coloured object by transmitted light. If no colour is transmitted the reflected colour is probably due to physical causes.

A considerable number of the chemical substances which owe their colour to structure are inorganic in origin, and the colours depend mainly on the presence of some colour-producing metal; for example, chromium, cobalt, copper, and so forth. They are mostly used as pigments for the production of coloured surfaces by painting, or for the production of coloured decorations on china. Of these I do not propose to make any mention, not because they are unimportant as coloured substances, but because they do not trace any relationship to the stains and dyes which belong to organic chemistry, and are bound up with the recurrence of one particular element, namely, carbon.

There are some 300,000 definite compounds of carbon known, and the activities of research chemists add, perhaps, 4000 to these yearly. The majority of these compounds are colourless in the sense that they give only general absorption throughout the visible region of the spectrum. Some are, however, coloured—that is, they give selective absorption within the visible region—and it is evident that in these cases the colour cannot be ascribed to the presence of some particular metal, as with the metallic pigments, but must be due to some special condition of the element carbon. As a matter of fact, it is due to what is known as the "unsaturated state." The greater number of known compounds of carbon are "saturated" in the sense that all affinity which the carbon atom possesses for the atoms of other elements is fully satisfied. This is the case when carbon combines with hydrogen to form methane CH_4, or when it combines with oxygen to form carbon dioxide CO_2. No carbon compound of this type possesses colour, and every "saturated" compound shows general absorption of light. It is possible, however, to cause carbon to combine with carbon by more than one valency, and in such a case a condition of "unsaturation" arises:



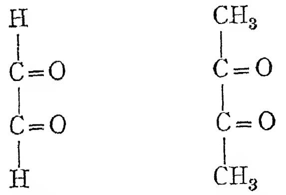
Ethane (saturated) Ethylene (unsaturated).

The affinity of each carbon atom is no longer satisfied by its proper quantity of hydrogen (or oxygen), and since there is naturally always a tendency for the substance to acquire the hydrogen atoms necessary for saturation, the "unsaturated" condition is definitely less stable than the saturated state.

The presence of one unsaturated linkage does not, however, confer colour on an organic compound—at least two being necessary for the purpose. It is also necessary that the two double linkages should be separated by one single linkage. This is known as the conjugated system of double linkages, and its presence in an organic compound apparently confers on it the property of producing selected absorption in the visible

[1] Discourse delivered at the Royal Institution on Friday, April 11.

region of the spectrum. The simplest possible coloured organic substances are therefore glyoxal and diacetyl:

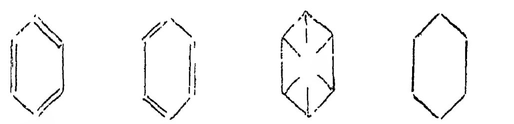


Glyoxal. Diacetyl

These substances, however, although they are of great interest as showing the origin of colour in organic substances, are relatively unimportant owing to their slight colour and their rarity. It is to the derivatives of the hydrocarbon benzene, upon which is based the chemistry of the coal-tar colour, that special interest attaches.

As already mentioned, benzene shows selective absorption in the ultra-violet region of the spectrum, and is therefore visibly colourless, although, chemically speaking, it possesses marked colour. The great number of the derivatives of benzene are, therefore, visibly colourless, but the chief point which has to be remembered is that, although visibly without colour, these derivatives possess potentially visible colour, and it is always possible to produce visibly coloured substances from them by modifying the molecular conditions which lead to the selective absorption causing visible colour.

The organic chemist's conception of the structure of benzene is still that which was propounded by Kekulé some seventy years ago, and it is fair to say that no theory, either physical or chemical, has been brought forward since then which can be regarded as quite adequate. Kekulé regarded benzene as a substance containing a conjugated system of double linkages, upon which the colour of organic substances depends; but in order to account for the peculiar properties of benzene, its remarkable stability, and the formation of its derivatives, it is necessary to postulate a symmetrical formula which is expressed either by the Armstrong formula or by the simple hexagon—a necessity, which was met by Kekulé by the supposition that there was rapid dynamic interchange between the two unsaturated individuals of his formula. Below are given the forms of linkages which have been given to the benzene molecule, the carbon atoms, assumed to occur at the points of the hexagon, being omitted:

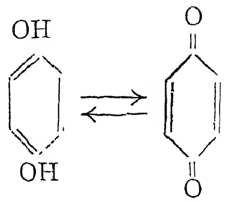


Kekulé (I). Kekulé (II). Armstrong. Conventional form

This dynamic interchange, leading to symmetry, is expressed both by the Armstrong formula and by the conventional formula, but it is evident that each of them is merely a compromise, and represents an intermediate condition between two rapidly interchanging forms. They do not mean more than this, because any condition which postulates the existence of trivalent carbon has to contend with a number of cases in which the occurrence of this condition leads to instability quite out of keeping with the remarkable stability of benzene and its analogues and derivatives. This is the case with triphenylmethyl and similar compounds.

The dynamic conception of the structure of benzene supplies a reason for the recurrence of the strong ultra-violet absorption which is characteristic of this substance. Moreover, it suggests that if it were possible to modify the conditions leading to this absorption, it might be possible to throw the absorption within the visible range of the spectrum, and thus produce visible colour.

The simplest visibly coloured member of the series is quinone, which is produced easily from hydroquinone by oxidation and is reconverted into hydroquinone on reduction:



Hydroquinone. Quinone.

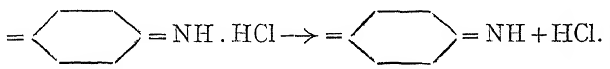
Here, then, at any rate, we have one means by which we can produce visible colour from a benzene derivative. There are certainly other means, but these are not as yet so clearly defined, and there is no question that when H. E. Armstrong propounded his quinone theory of colour he enunciated the fundamental principle on which the chemistry of the coal-tar colours is based. For there can be no doubt that the colours of these compounds are due to the presence in them of a quinone residue, which, acting like the simplest quinone ring shown above, throws the ultra-violet absorption of the visibly colourless benzene derivative into the visible region of the spectrum.

This is easily shown by the conversion of the visibly colourless phenolphthalein into its coloured alkali salt. However, it is a simple matter by altering the groups present to throw the absorption into any portion of the visible spectrum required, and thus to obtain any desired colour. The chemist is able, therefore, while retaining the same skeleton, to produce any colour at will by merely altering the nature of attached groups.

The name coal-tar colour is derived, of course, from the fact that the parent hydrocarbons from which the colours are derived—the benzene hydrocarbons and their analogues—are obtained by the distillation of coal-tar. The first of the series, mauveine, was discovered by the late Sir William Perkin in 1856, in an attempt to prepare the alkaloid quinine synthetically. But Perkin did more than discover a new series of colouring matters. He also introduced a new method of dyeing. Up to that time, dyeing had been a composite process involving the actual formation of the coloured substance on the fibre itself. The two chief processes in use were (*a*) that of vat-dyeing and (*b*) that of mordant dyeing. The first, represented by indigo dyeing, involved the reduction of the coloured substance (indigo) to indigo-white, a material soluble in alkali; the steeping of the fibre in the solution and the reproduction of the insoluble dye by means of the

oxygen of the air. The second required the previous impregnation of the fibre with a metallic hydroxide and the subsequent formation of a coloured lake on the fibre by steeping the prepared material in a dyestuff (alizarine) capable of yielding such a lake.

In each case, therefore, two distinct processes were involved. In the process introduced by Perkin only one operation was necessary. The dye contains, as already mentioned, a quinone or quinonimine residue, which causes the dyestuff in the form of its salt to be soluble in water:



Dye Salt. Dye.

It happens that the coloured base is soluble in the wool fibre, and when the fibre is added to the dye-bath the coloured base is extracted, leaving the mineral acid free in solution. The operation is of the same order as that which determines the extraction by, say, ether of an organic substance soluble in water. The coloured base is not, however, soluble in cotton, and hence this material is not coloured in the dye-bath.

These are known as the basic dyes; and a similar effect is produced by the acid dyes, although, since these are the sodium salts of sulphonic acids, the dye-bath has to be rendered acid previously in order to liberate the free sulphonic acids, which then dissolve in the substance of the wool. Cotton would not, of course, be coloured by this process, although, as it was found that the new basic colours possessed the power of giving an insoluble coloured compound with tannic acid and an antimony salt, it was possible to affix them to the cotton fibre by a two-process method, involving the previous treatment of the material with tannic acid and tartar emetic.

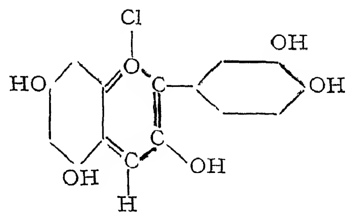
It was not until twenty years later that it was found (Böttinger, 1886) that a certain type of azo-dye derived from benzene possessed the property of being soluble in the cotton fibre, a discovery which led to the preparation of the large number of substantive cotton dyes known at the present day. In this case it is the sodium salt of the sulphonic acid which is extracted. This discovery was entirely accidental, but, as so often happens in organic chemistry, it was found that the property was possessed by a large number of substances of the same type, or having the same skeleton formation, and, since it is possible readily to alter the shade by varying the nature of attached groups, the series contains representatives of all shades of colour.

It must be remembered, however, that there is a marked difference between the two methods of dyeing —one, the older method, in which the dye is formed in the fibre, and the other, the newer method, in which the fibre acts merely as an extractor for the coloured base, acid, or salt. It is evident that, other things being equal, the older processes should give the faster dyeings; that is, the colour would be more firmly fixed in the fibre and less likely to be affected by the various conditions, such as exposure to light, washing, etc., to which a dyed fabric has usually to be subjected. This is, as a matter of fact, the case, and numerous processes have been devised by which the stained fabric (as I prefer to call it) can be rendered more fast by after-treatment; that is to say, by causing another colour to be produced in the fibre from the colouring matter already there. One of the best illustrations of this is the method by which an azo dye can be produced on the fibre from a stained fabric which has been stained by a substance having an NH_2 group:

$$-NH_2 . HCl \longrightarrow -N=NCl \longrightarrow -N=N . R . OH.$$

There are many other methods, such as after-treatment with metallic salts, or with formaldehyde, which can be employed. Indeed, such processes would be still more necessary were it not for the remarkable tenacity with which the stained fabric, in many cases, retains its stain. The affinity varies in different cases, both as regards the power and speed of absorption, and is probably connected with the size of the molecular (colloidal) aggregates which are present in the dye-solutions. It is not connected with the actual molecular weights.

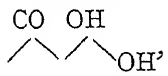
Nevertheless, although there are some stains which possess so marked an affinity for the fibre as to render them comparable with true dyestuffs (those produced on the fibre) in fastness, and some which lend themselves to after-treatment, and fall therefore within the category of true dyestuffs, there are a large number which possess all the inherent disabilities of the class; that is, they are unsaturated organic compounds tending to pass into the saturated (colourless) state under favourable conditions. Such conditions are always present in the oxygen of the air, which in the presence of light constitutes a formidable opponent to all coloured organic compounds. As already mentioned, Nature got over this difficulty in the case of bird's feathers and butterfly's wings and also in the wing cases of coloured beetles by ignoring the organic colour altogether She utilised them, however, in the case of the flowers, but chose substances highly oxygenated in structure, which would be least likely to be affected by air and light. For example, the colour of the red rose is delphinidine,

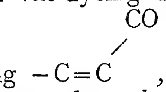


and this is also the basis of the colour of the blue cornflower, the only difference being in the character of the group attached to the oxonium oxygen.

However, as the science of organic chemistry advanced, it became possible to contemplate the synthetic preparation of some of the natural colouring matters, of which indigo, alizarine, and logwood were types. These are not natural colouring matters in the sense that they are used by Nature as such, but have been evolved by man for his own purpose by a process of trial and error. They represent the survivors of a vast number of natural substances with which man must have experimented throughout the ages in order to produce colour for his own purposes. Together with certain mordant colours derived from lichens, which are still used for dyeing in certain parts of the country, they constituted the sole means of producing

dyed fabrics at the time when the coal-tar colours were discovered. Their value as dyestuffs was without question, the world's yearly consumption of indigo alone, at that time, representing some 4,000,000*l*.

It must also be remembered that it was not the question alone of the commercial production of the dye in competition with the natural product which was sought, because this must have appeared a totally impracticable problem in those early days. It was rather the search for the reason why alizarine was a mordant dye and why indigo was a vat-dye which was the incentive to research, because when these facts were discovered other substances having similar properties could be prepared. The attack in every case followed the usual lines. In the first instance, the structure of alizarine (the mordant dyestuff of the madder root) was revealed by analysis, when Baeyer found that it gave anthracene on distillation with zinc. Its synthesis from the anthracene of coal-tar followed in the next year, being effected almost simultaneously by Graebe and Liebemann in Germany and by Perkin in England. In this case the preparation was so simple and the raw material so easily obtained that the natural madder industry was rapidly killed. The determination of the formula and synthesis of alizarine showed the particular grouping, namely, , on which mordant dyeing depended. Hence the preparation of a large number of analogues of varying shades of colour followed.

The determination of the structure of indigo took longer, and occupied Baeyer at Munich some eighteen years. In this case the colour was synthesised and manufactured on a commercial scale three years before its structure was determined, because, as sometimes happens, a reaction, the course of which was then unknown, led to the formation of the dye. Here, again, the determination of structure showed that the property of vat-dyeing depended on the presence of the grouping , and in consequence, whereas blue indigo was the only known member of its class in 1890, at the present day every shade of colour is represented in this particularly fast series.

Finally, at the beginning of the present century, the accidental discovery of indanthrene by Bohr placed on the market the first member of a series of vat-dyes, which constitutes without question the fastest series of colouring matters hitherto prepared. Practically all shades of colours are represented, the principle of dyeing being essentially the same as that of indigo.

Before the War we relied mainly on Germany for the production of our dyestuffs, and, what was still more serious, we left to them the research work on which the production of new dyestuffs depended. Dyestuff chemistry is merely a branch of organic chemistry, which includes also the preparation of organic chemical substances used in a variety of industries essential in peace and war. The possession of a dyestuff industry implies, therefore, the possession of a band of trained organic chemists and, what is more important, the possession of university and university college laboratories, where organic chemists can be adequately trained in methods of research. As a member of the Dyestuffs Development Committee, it has been my good fortune within the past six months to visit all the dye-producing factories operating in Great Britain, and I have been struck with the very real success which has attended the efforts of the past five years to establish the industry. If we had merely reached the level of excellence attained in Germany before the War, the fact would have been very creditable, but we have done more than this, and in several cases, notably in the production of a new indanthrene green, we have already drawn ahead; a position, it is to be hoped, we shall not again lose.

Some Geographical Aspects of the British Empire Exhibition.

THE British Empire Exhibition at Wembley, in the north-west outskirts of London, strikes at once a note on the Empire as a unit. From the Palace of Engineering, with its sense of the fullness of the metallurgical industries of Britain, across the way to the Palace of Industry, almost crowded out with the multifarious products of Britain's factories, one gathers an impression of diversity as shown by fountain-pens and gramophones in contrast with big guns and giant railway engines, of high quality from the silks and laces to the coach-work on the motor cars, of stability from the various types of safe and strong room to the giant turbines; and, withal, there is a feeling of much energy crowded into a tiny space. Visit may succeed visit to these two great palaces, the main monument to the occupations of Britons at home, and yet their innermost recesses, their by-ways, and their out-of-the-way corners would not all be explored; it would appear that the visitor is left deliberately with few indications of the wealth of British products here housed, for each visit brings to light something previously missed and leaves the thought that there is yet something more to find.

The British Isles are thus presented as a crowded hive of industry, and this impression is intensified when one penetrates below the surface. Mannequin parades, exhibits of machine processes in cotton, paper, and so forth, are co-operative efforts; they are not labelled as the work of one firm or as, necessarily, the product of one district; they are specimens of Britons' work. The student of geography who wishes to emphasise or correct his book-lore is driven to much mental effort to analyse the contents of these great buildings, to sort out the products, say, of the Black Country and to localise the various elements of industrial Britain. Except in a few instances, mainly in the food section, the visitor is not asked to buy, and the exhibit is not primarily designed as an advertisement; in this respect the student would penetrate deeper and more easily into the mysteries of British manufactures at one of the annual trade shows, such as the British Industries Fair or the Motor Show. Of course, customers from overseas can get into touch with manufacturers, but the trading element, the business of selling the goods, is kept in the background; here is primarily an exhibit of what

can be produced by the British Isles as the chief congeries of factories in the Empire.

Over against the impression of works jostling with works to pour out useful commodities for use throughout the Empire lies the first, and the dominant, feeling which is aroused by the pavilions devoted to Australia, Canada, and New Zealand. Each of these suggests life in the open spaces where there is room and to spare for all; a largeness and perspective about the exhibits strikes immediately the right note. In the same spirit the divisions of the country are obscured; it is intentional that the visitor should have to make an effort to discover whether he is examining the products of New South Wales or Victoria, of the Canterbury Plains or Taranaki. Take the simple matter of apples; the housewife at home is concerned with the quality of the fruit, not with the location of the orchards; in each pavilion she may see and buy fine specimens, and she carries away the notion that the greengrocer may supply Canadian, Australian, or New Zealand apples; she may see adjacent pictures of Canadian orchards and only after diligent inquiry learn that one picture shows life in the Annapolis Valley and the other a scene in British Columbia, places 3000 miles apart. Similarly, butter is seen in refrigerating chambers in Canada and New Zealand, sheep are sheared in Australia, timber of all kinds, undressed, dressed, worked into furniture, is shown from all three countries. Canada invites attention to her magnificent water supply with its uses for power installations; Australia indicates by a model farm the irrigation of an arid area.

In these pavilions, as elsewhere, the complete exhibit is a concrete demonstration of the products of each country as a whole, and the best guide to the pavilion is probably a list from a Blue-book of the products of each land; there is little attempt to indicate relative importance; each country says simply, This is what we can do, this is our contribution to the Empire's needs, will the Empire make use of our efforts?

In this regard the main part of each show deals with a few primary products, meat, wool, ores, timber, but a similar note is struck regarding the factory products of the chief towns. Emphasis is not laid upon the work of Toronto in competition with Montreal or of Melbourne rather than Sydney, but upon the one main fact that Canada and Australia can make house furniture, boots and shoes, apparel, and so on, of a quality which exceeds expectation. Canada is not merely a farmer's land, a land of the backwoods and prairie; Australia is more than a home for the squatter or the bushranger. Even the prairies or the Australian back-blocks are no longer the scene of primitive human labour, that of the hands; the prairie quarter section is depicted near a railway with a convenient elevator against which a moving train stops until the grain has poured into the truck; Australian sheep are sheared and Australian cows are milked by machinery.

Leaving the spacious lands the visitor reaches, in turn, India, Burma, and Ceylon, and again receives the right impression of crowds and ceaseless activity, but with this difference, that the activity is concerned, on the whole, with products each of small import. So there comes before him the questions of cotton, tea, and rice. In the Palace of Industry a cinema has told him the story of cotton, and machinery has whirred and clanged as the fabrics were made before his eyes; here are the raw material, the native weaver, and the native product all in readiness for the contrast to be obtained from a subsequent visit to the African pavilions to find experimental cotton growing and other native looms at work.

Here, and more forcibly at Hong-Kong, the spirit of the Eastern bazaar is displayed; here is the peddling of home-made products and the country's curios. Rightly, perhaps, the primitive elements of Indian life are hidden except in relation to the ameliorative work of the missions, India being presented rather from the point of view of the business and needs of the Empire than from that of a true perspective picture of what Indian life is like in all its degrees.

Thus the visitor passes to the smaller sections of the Empire, the best guide, as always, a Blue-book list of products, cocoa, kola, palm oil, rubber, and so on, for the Gold Coast, for example, and in addition, both within and without the pavilions, a skilled attempt to produce the essential atmosphere of the colony with native craftsmen, native scenes, and the products of domestic industries. The tour so far has been a continuous descent in the scale from the English locomotive and the Canadian motor-car to the Indian shawl and the West Coast brass or silver bowl with a hammered pattern, from a Doulton vase to a piece of African pottery. Diamonds, gold, ostrich feathers in South Africa, fish, paper-making, and the Newfoundland dog in Newfoundland, oranges in Palestine, an interesting historical exhibit in Malta, whaling and sealing in the Falklands, copra in Fiji, are but a tithe of the things to see in the remaining pavilions.

Imperial communications are focussed in an interesting model in the Government pavilion, but they are constantly to the fore elsewhere, either in the separate pavilions of the Canadian railways, or as specimens of railway carriages or ship's quarters or as model steamers or models of docks and wharves in the several Imperial units. The would-be settler has every inducement to find out all he wishes to know about any land which attracts him, and Imperial comparisons are possible under the guidance of the Department of Overseas Trade.

Health questions in the Empire are dealt with in the Government pavilion in a section which deserves to become more popular.

In every corner the visitor is carried away to some distant land, from every detail he gathers a suggestion which leads cumulatively to a notion of what each name, Malaya, British Guiana, East Africa, implies, and even a scamper of merely one day's visit through the several pavilions gives reality to these far-off homes of Britons overseas, and the wise visitor probably pauses and looks back over the pavilion itself to grasp the message it conveys; the colour scheme of West Africa, the caribou and bison of Canada, the Maori whare and Samoan hut, the pillars at the entrance with the pagodas of Burma, the Indian pavilion as a whole, all contribute to the general effect, which is intensified by the slow passage over Old London Bridge with the views from either end, the old heart of the Mother City brooding over the wonders brought into being by her sons, the Empire builders.

The Toronto Meeting of the British Association.

LOCAL ARRANGEMENTS

(From our Toronto Correspondent.)

THE local arrangements for the Toronto meeting of the British Association in August give promise of an interesting time for visitors from the east side of the Atlantic. Committees have been busily engaged with arrangements for local entertainments, sectional excursions, and the main excursion through western Canada to the Pacific coast, which is to take place after the meeting. It is now possible to give a summary of the arrangements which have been made.

The main party of visitors from England is expected to arrive in Quebec on August 2. There they will be formally and appropriately welcomed, and will spend a day at Quebec, leaving late in the evening. They will arrive in Montreal on the following day, and accommodation is being reserved at hotels where visitors will spend a welcome day of rest. On August 4 excursions have been arranged to Macdonald College and to the Port of Montreal. A botanical excursion has also been arranged. While definite plans have not yet been made, it is proposed that the party be divided in Montreal into two approximately equal groups. One of the groups will leave for Ottawa late in the evening of August 4, and will spend the morning of August 5 there, take part in certain official functions and entertainment, and leave for Toronto at midday. The other group will go directly from Montreal to Toronto by night train on the evening of August 4, arriving in Toronto on the Tuesday morning.

For the social side of the meeting in Toronto, several garden parties, receptions, ladies' luncheons, and other entertainments have been arranged. Among these are a recital of Canadian music and the performance of a Canadian play in the theatre of Hart House. An exhibition of Canadian paintings will be on view throughout the meeting at the Toronto Art Gallery, which is five minutes' walk from the University.

On Thursday, August 14, a general excursion has been planned to Niagara Falls. Other excursions to Niagara Falls and its vicinity will be undertaken by sections for their own purposes, and it is suggested that those who wish to go to Niagara primarily to see the Falls should take part in this excursion on August 14 to avoid unnecessarily enlarging the sectional excursions during the meeting.

The following sectional excursions have been planned:

On August 8 the Chemistry Section will visit the industrial plants around Niagara Falls, Welland, and St. Catharines. On this excursion the chemists will spend the night at Niagara Falls.

The Geology Section will make the following excursions:

On the afternoon of August 7, together with a limited number from the Geography Section, they will travel by motor-cars to various points in the vicinity of Toronto where palæozoic rocks may be seen. The party will be under the direction of Prof. Parks, of the University of Toronto, and is limited to fifty. On the afternoon of August 8, under the direction of Prof Coleman, they will visit various localities in the vicinity of Toronto for the purpose of studying glacial phenomena. This party, which will travel in motor-cars, is limited to seventy-five. On August 9-10 they will visit the Niagara-Grimsby district under the direction of Profs. Coleman and Parks. This excursion is limited to sixty participants. If a sufficient number desire, arrangements will be made for another excursion to the Pre-Cambrian area in eastern Ontario. This excursion would leave Toronto on the evening of August 8, and return on the evening of August 10. It would afford an opportunity for studying the Laurentian and Grenville formations.

In the Zoology Section there will be a motor trip on the afternoon of August 8 to the Forks of the Credit River; on the afternoon of Monday, August 11, a motor-launch trip on Lake Ontario for the purpose of examining the plankton; and on the afternoon of August 12 a motor-car excursion to Schomberg Swamp on the Holland River.

In the Engineering Section on August 9 the engineers will journey by steamers and cars to various engineering works, such as the Welland Canal and the Queenston Power Plant, in the vicinity of Niagara. This excursion will occupy the whole day. On August 11 they will inspect the works of Toronto harbour, making the tour by boat.

The Psychology Section will make a motor excursion to the Ontario Hospital at Whitby on August 9.

The botany excursion will visit High Park, Swansea, and Humber Valley on the afternoon of August 7. And from the evening of August 8 to the evening of August 10 they will camp in the vicinity of Niagara Falls and make various excursions to points of interest to botanists. On the afternoon of August 12, provided with footware suitable for wading, they will visit the Sphagnum Marsh on Holland River, 33 miles north of Toronto, returning to Toronto late in the evening.

The following sectional excursions will take place after the meeting:

A party of geologists, limited to twenty-four, will leave for northern Ontario on the evening of August 14 in a special Pullman car, and will spend the following five days at Temagami, Cobalt, Kirkland Lake, and the Porcupine district. Those geologists who are going on the western excursion will join it on August 19. The northern Ontario excursion will be free of any expense, and members taking part in this and the succeeding botanical excursion will be guests of the Provincial Government of Ontario until they join the western excursion.

A party of botanists, limited to twenty-five, will also leave on the evening of August 14 for Temagami, and will proceed to the summer station at Bear Island. This excursion, which will entail no expense to the participants, will join the western excursion at Temagami early on Monday morning.

Members of the Agricultural Section will visit fruit farms in the Niagara district on August 15. They will also visit certain stock farms and the Ontario Agricultural College at Guelph. They will spend the night of August 15 at Guelph and return to Toronto in the afternoon or evening of August 16, in time to join the western excursion.

The Western Excursion.—This excursion, as has already been announced, will journey from Toronto to

Vancouver and return. Two trains, half an hour apart, will leave Toronto on the evening of August 17. The trains will proceed westward by the Canadian National and Temiskaming and Northern Ontario Railways, and return by the main line of the Canadian Pacific Railway in time for those sailing from Montreal or Quebec to catch their steamers on September 4. An opportunity will be afforded to visit mines and concentrators at Cobalt, and the mines and mills at Kirkland Lake and Timmins. A day will be spent at Winnipeg, a half day at Saskatoon. At Saskatoon a meeting of the Chemistry Section will be held at the University of Saskatchewan, and a new chemical laboratory will be formally opened. Another day will be spent in Edmonton, where Sections C and K will hold short meetings at the University of Alberta. A short visit will be made to Jasper Park.

Arrived at Vancouver, members desiring to do so may visit Victoria by steamer. In Vancouver and its vicinity visits will be paid to great saw-mills, salmon canneries, and copper mines, and short technical sessions will be held at the University of British Columbia.

A train will leave Vancouver on August 26 and 27 respectively. The first train will make stops of suitable lengths at Glacier, Lake Louise, and Banff, and the second at Lake Louise and Banff. From Banff eastward the trains will travel half an hour apart, and stops will be made at Calgary, at Fort William, and at Port Arthur, where the grain elevators will be visited. The trains will also stop at Sudbury, where the mines and smelters of the famous Sudbury nickel region will be the last important feature to be studied.

As has been already announced, the expense for this excursion, including sleeping accommodation, will be 100 dollars return Meals will be provided on dining-cars. The local committee is endeavouring to get especially low rates for meals, but it is unfortunately not yet possible to announce what these rates will be.

Appropriate guides with detailed itineraries have been prepared for the western and other excursions, and will be issued at the reception room during the meeting. It is unfortunate that the demand for space on the western excursion has been so great that it will be necessary to limit the number of those participating, who will be chosen from the list of applicants during the meeting. Needless to say, preference will be given to overseas visitors.

Obituary.

SIR SYDNEY RUSSELL-WELLS.

BY the death of Sir Sydney Russell-Wells, which happened with tragic suddenness on Monday, July 14, the cause of education, and especially of university education in London, has suffered a heavy loss. With no outstanding scientific achievements to his name, no published work that could be called noteworthy, the founder of no scientific school of thought, he nevertheless succeeded by dint of courage and perseverance in winning a place of honour as a friend of educational development and as a university administrator.

A Londoner by birth, Sir Sydney Russell-Wells received a sound training in science at the old Royal College of Science and University College, proceeding afterwards to St George's Hospital Medical School, where he had a distinguished career culminating in the passing of the London M.D. in 1895. He held the appointment of Senior Physician at the Seamen's Hospital, Greenwich, and of Physician at the National Heart Hospital. In more recent years, while retaining all his interest in general medicine, he tended towards specialisation in diseases of the heart, and won a reputation as a sound and trustworthy diagnostician.

But it was in the University of London that Sir Sydney Russell-Wells's main interest lay, in the University in which he had graduated in science and in medicine, and which at the time of his death he represented in Parliament and on the General Medical Council. Into the controversies of the University he threw himself in his earlier days with keen interest, with knowledge, and, it must be added, with zest. When, however, an opportunity presented itself of rendering service of a positive, constructive kind, he was not slow to avail himself of it. To him more than to any one is due the existence of the School of Commerce in the University, and to him the recognition, tardy but generous, on the part of the City of London of the fact that there was a great University in London. When in 1920 he was elected Vice-Chancellor of the University, he set himself deliberately to the task of impressing the University upon London, and there is no doubt as to his success. His methods were perhaps open to criticism at times, especially among some of the older members of the University, but no one doubted his zeal and energy, his passionate faith in the future of the University, and his jealousy for its rights and prerogatives.

Sir Sydney Russell-Wells's tenure of the office of Vice-Chancellor lasted nearly three years, and the occupancy of the post undoubtedly broadened his experience and enlarged his outlook. He had been a doughty exponent of the claims of the external student, and while he held consistently to the view that the University merely as an examining body was an agency for good, closer acquaintance with its teaching work, which during his Vice-Chancellorship had enormously expanded, filled him with enthusiasm, and he never ceased to play the part of reconciler between opposing schools of thought. He was also largely responsible for the difficult and intricate negotiations which led to the acceptance of the Bloomsbury site for the University. Much of his work was accomplished under great difficulties, for although he was a skilful and well-informed conversationalist and most persuasive talker, he had no gifts of oratory, and his health, never strong, was taxed severely by the strain he put upon himself. But he kept grimly on, knowing, as he must have known, that he would have to pay the price. He died at his work, and his devotion to it and to his University will be long remembered by his friends and his colleagues.

AT the moment of going to press, we learn with much regret of the death in London on Monday night, July 21, of Sir William A. Herdman, emeritus professor of natural history in the University of Liverpool and president in 1920 of the British Association.

Current Topics and Events.

A SOCIETY for Cultural Relations between the peoples of the British Commonwealth and the Union of Socialist Soviet Republics has been founded recently in London. The objects of the Society are: (1) To collect and diffuse information in both countries on developments in science, education, philosophy, art, literature, and social and economic life; (2) To organise lectures and an interchange of lecturers, conferences, exhibitions, etc., and to arrange for the publication and translation of papers and books; (3) To provide opportunities for social intercourse; (4) To take any action deemed desirable to forward the intellectual and technical progress of both peoples. Russia has unfortunately been cut off from all other civilised countries for about ten years, owing to the War and the revolution which followed it. Only in this year has it been possible to break down some of the wall separating Russia from other peoples. Through the crevices Europe begins to see that, in spite of the most difficult conditions prevailing in science and art, the great spirit of Russia is still alive and even active. Hunger, shortage of necessary technical materials, apparatus and books, the necessity of working in rooms and laboratories where the temperature in winter was near freezing-point, prosecution by the Government—all this has not killed the spirit of Russia. The attempts of the Government to proletarise science and art have not been very successful for a simple reason, namely, there is only one truth, the same for proletarians and bourgeois, the desire for which is that peculiar feature which distinguishes a man from an animal. For Russians the breaking down of the wall surrounding their country has become much more important than for countries which are outside this wall: the development of western science, art, literature, philosophy, and social life, which is free and not "controlled" by Government and has proceeded under normal conditions of life, has resulted in remarkable progress. There is no need to point out how vital the knowledge of this progress is to Russia. From this point of view, it is necessary only to wish all success to this new society, provided it does not become an official organisation, but remains free from any official control and concerns itself only with the promotion of friendly relations between the intellectual representatives of both countries.

BY the retirement, after fifty years of service, of Dr. H. J. H. Fenton, who went to Cambridge in 1874 as an undergraduate of Christ's College, the University has lost a well-known personality and the Chemical Department a distinguished man of science. Dr. Fenton has taken part in the development of chemistry in the University from its infancy, since he became junior demonstrator, under Prof. Liveing, some years before the new laboratories, the nucleus of the existing buildings, were completed and occupied in 1888. In 1886 Fenton published an investigation on the hydration of ammonium carbamate to ammonium carbonate in aqueous solution, in the course of which he employed a novel method of analysis depending upon the fact that sodium hypochlorite sets free only the ammonia nitrogen, whilst sodium hypobromite liberates the amide nitrogen as well. In 1894 he began a fruitful series of researches on the oxidation of hydroxy-acids by hydrogen peroxide in the presence of traces of ferrous iron as catalyst. At an early stage of this work he prepared from tartaric acid the interesting compound dihydroxymaleic acid, and by heating it with pyridine obtained the simplest sugar, glycollic aldehyde. In 1899 Fenton and Miss Gostling discovered the chloro- and bromo-methyl furfuraldehydes, which they obtained by treating ketohexoses or cellulose with the corresponding halogen hydrides. Apart from their intrinsic interest, these compounds formed the basis of new colour tests for certain classes of compounds; *e.g.* by treating bromomethylfurfuraldehyde with malonic ester in the presence of alcoholic potash a fluorescent material was produced, which Fenton showed could be employed to distinguish hexoses from pentoses. Another interesting substance, termed by Fenton methylfuril, gave colour-reactions with primary amines and carbamides. Readers of Fenton's "Outlines of Chemistry" and of his more elementary "Physical Chemistry for Schools" will obtain some idea of the scope of the material which formed the basis of his lectures, but only those who followed the lectures were aware of the masterly treatment of the subject. His "Notes on Qualitative Analysis" constitute the *vade mecum* for thousands of students of that particular branch of practical chemistry.

AN exhibition is now being held in the Assyrian Basement of the British Museum of some of the objects found by the Joint Expedition of the Museum and the University Museum of Philadelphia to Mesopotamia during 1923–24. The principal objects now shown were found around the Temple platform at Tell el-Obeid about five miles from Ur. Of these, the most important, from the historical point of view, is the marble foundation tablet bearing the hitherto unknown name of King A-an-ni-pad-da of the First Dynasty of Ur, which dates back to before 3000 B.C. The exhibit includes a pictorial representation by Mr. C. L. Woolley of the walls and entrance of the temple as they stood originally. This enables visitors to appreciate the significance of the remarkable collections of models of animals and the friezes in bas-relief which adorned the walls with representations of animals and scenes of agricultural life. A wonderful copper statue of a bull some 2 ft. 4 in. high and 2 ft. 8 in. long is undoubtedly the oldest hollow statue now known to exist. It reveals a remarkably high technique for so early a date. It was made by carving the body and limbs in wood separately, and fastening them together with copper wire. Thin copper sheets were then hammered over the whole. The exhibition includes several examples of the use of different coloured *tesseræ* inlaid in bitumen for decorative purposes. The collection will be on view for about two months before it is apportioned to the British Museum, Philadelphia and Baghdad.

THE Natural History Branch of the British Museum, which started its series of picture post-cards not long ago, has gone ahead with them rapidly. Some beautiful examples in colour have been produced by Messrs. Stone, Waterlow and Sons, and W. F. Sedgwick. Of these, 70 cards illustrate insects, 10 birds, 5 reptiles, and 15 plants; and 20 cards represent 122 eggs of British birds. The monochrome series comprises 20 views of the building, 90 mammals, 35 birds, 40 insects, 25 plants, 60 fossils, 15 meteorites, 15 reptiles, 10 corals and sponges, and 10 rare and curious natural history books. Among recent additions, those in colour of British flowering plants promise to be as useful as they are attractive; each shows a plant or spray in flower, a single flower, fruit, and sections; they are made from drawings, but the name of the artist is not given. There are three sets of very life-like reptiles and batrachians, presumably from exhibited specimens. Miss Alice B. Woodward, who worked under the guidance of the late C. W. Andrews, has contributed six characteristic reconstructions of extinct mammals, mainly Proboscidea. New ground is broken by a set illustrating the life history of the common eel, based on the memoir and photographs by Dr. Johs. Schmidt. The educational value of all these cards is considerable, and teaching establishments not already acquainted with them should write to the Director for the latest list.

THE statement of activities of the National Research Council of the United States for the year ending June 30, 1923, is now issued as Circular 49 of the Council It appears that the Council now derives the whole of its finances from other than Government sources, and is in consequence entirely controlled by its own chosen officers. Its budget for the year was half a million dollars, and in addition it is spending one and a third million dollars on the new building at Washington to accommodate the Academy and the Council, described in NATURE of July 22, 1922, p. 120, and June 28, 1924, p. 940. It maintains about 100 post-doctorate research fellowships in physics, chemistry, biology and medicine from funds derived from the Rockefeller Foundation. Under its sponsorship a considerable number of special organisations carry on research on physical, engineering, chemical, geological, biological, anthropological, psychological and medical questions, such as the structure of the atom, research chemicals, petroleum, sex problems, immigration, food and nutrition. There can be no doubt as to the determination of the people of the United States to make their country a great centre for research, nor as to the energy with which they are carrying out their intention

IN his presidential address to the Society of Chemical Industry, delivered on July 9 in Liverpool, Dr. E. F. Armstrong referred to the success of the chemical exhibits at the British Empire Exhibition, of the chemical literature which has been issued in connexion therewith, and of the Bureau of Chemical Abstracts, which has been formed to prevent overlapping in the abstracts that are issued by the Chemical Society and the Society of Chemical Industry. On the other hand, he deplored recent signs of increasing competition between the various chemical societies, and the inaction of the Federal Council for Pure and Applied Chemistry in regard to the further consolidation of chemical interests and the establishment of a central Chemistry House. The greater part of the address consisted of a dissertation on the fats, written in collaboration with Mr. John Allan, which gives an excellent survey of existing knowledge and problems in this important field, and would be still more valuable if it had been published with full references to the original literature

A MARKED degree of success appears to have attended the tests of wireless reception and transmission to and from a moving train carried out by the Radio Society of Great Britain on July 4 An experimental apparatus both for sending and receiving was installed on the express train leaving King's Cross at 7·38 P.M. for Newcastle, and signals transmitted from the train were received at distances of more than 200 miles. Observers in London could hear the signals distinctly while the train was approaching Newcastle (268 miles from King's Cross), and reception was reported from localities so far distant from the line as Shrewsbury and Glasgow. In spite of the deafening noise of the train, and other difficulties, the receiving apparatus worked satisfactorily, and those on the train were in touch with the transmitting station of the Society at Shepherd's Bush, London, while the train was passing through Darlington at 65 miles per hour. An experimental station at Bedford was kept in touch with for more than 150 miles. The complete analysis of the results is not yet available, but enough has been done to show that wireless communication with moving trains is a practical proposition.

THE Southend-on-Sea Public Museum (Prittlewell Priory) has just been enriched by the gift by Major Weber of the Hoy collection of birds (1797–1839). With one or two exceptions the Hoy collection is complete and consists of more than 260 cases. Most of the birds were taken in Essex, Suffolk, and Norfolk, and the collection contains many rare and valuable specimens. Among these are the first recorded British specimen of the pectoral sandpiper, bustards, ospreys, and eagles. The Southend Museum contains also the Christopher Parsons collection of birds (1807–1882) from south-east Essex, and since the Museum was opened in 1922 many rare bird visitors to the county have been secured by purchase, these including the first specimen of the yellowshank recorded in the eastern counties and the third in Britain, the smew; blue-headed wagtail; and numerous other birds. Major Weber's gift, added to the existing collection, makes the ornithological department of the Museum noteworthy among collections of local birds in Great Britain.

IN the seventh Trueman Wood Lecture delivered before the Royal Society of Arts on May 21 and just published in the Society's Journal, Sir William Pope spoke on "The Outlook in Chemistry," and gave a lucid exposition of recent progress in the field of atomic structure, valency, and crystal structure.

He referred particularly to the necessity of altering the methods of teaching chemistry which seems to result from this recent work. It was suggested that a preliminary account of the manner in which all the specialised parts of chemistry fit into the general scheme of the electronic structure of matter and energy should be given The suggestion was also made that progress in chemical discovery would be more rapid if organised research on specific problems were undertaken rather than individual work.

A FEW days ago the British Cast Iron Research Association formally took possession of its own Laboratories, in Guildford Street, Birmingham, which have been equipped for the conduct of chemical analyses and general metallurgical and heat treatment work. The capacity of the Association to deal with its work will thus be greatly increased, but it is not intended to abandon the policy of having investigations conducted in university laboratories and in the works of members. It is anticipated that the Association, which commenced a new financial year on July 1, will incur an expenditure during the year of between 6000*l*. and 7000*l*. The research programme includes investigations on erosion- and corrosion-resisting and other special cast irons; moulding sands; graphitisation; cupola practice; standardisation of test bars, materials and methods, facing sands and blackings, and cast iron to resist abrasive wear, and jointly with the British Motor and Allied Manufacturers' Research Association, automobile cylinders and pistons.

REFERENCE has already been made (May 24, p. 756) to the valuable "Handbook to the Exhibition of Pure Science" prepared by a committee of the Royal Society in connexion with the exhibits arranged by it in the Government Pavilion at Wembley The Handbook contains, in addition to descriptions of the exhibits, a most instructive series of twenty-two articles by leading authorities upon current scientific work and problems, and every student of science should possess a copy of it. We are glad to know that arrangements have been made for its sale outside the Exhibition through Messrs. A. and F. Denny, Ltd., 163A Strand, London, W.C.2, who can supply the Handbook direct or through booksellers. The price is 1*s*., or post free 1*s*. 3*d*.; and as the book contains 228 pages it is remarkably cheap, as well as superior to many volumes published at a much higher price, whether intended for the general public interested in science or for students in school or college.

THE annual field day at the National Fruit and Cider Institute of the University of Bristol, Long Ashton, was held on Tuesday, July 15, and was attended by a representative gathering of agriculturists and horticulturists from all parts of the West of England and even farther afield. Among those present were Lord Bledisloe, chairman of the Governing Body of the Station, and Mr. W. G. Lobjoit, Controller of Horticulture, representing the Ministry of Agriculture and Fisheries. The visitors were first given the opportunity of sampling the ciders produced during the last two seasons in the course of the Station's experimental work on cider-making. These were exhibited in the new wing recently added to the cider house. The variation in the quality of ciders due to seasonal influences was markedly illustrated by comparing ciders made in 1922 and 1923 from some of the more famous vintage varieties of apples, such as Kingston Black, Cap of Liberty, and Foxwhelp, the advantage being definitely in favour of the 1922 vintage. Among other interesting features illustrated by the ciders were the effects of storage of the fruit under various conditions prior to cidermaking, the results of natural fermentation of the juice as compared with fermentation of pasteurised juice by specially selected yeasts, and the different degrees of control of fermentation obtainable by methods of racking and filtration. After sampling the ciders the visitors were conducted through the fruit plantations to inspect the various features of the experiments at present in progress. The attention of the parties was directed by guides to the numerous field investigations in progress on many subjects of importance to the fruit-growing industry.

MR. R. M STEWART, assistant director of the Dominion Observatory at Ottawa, has been appointed director of the Observatory in succession to Dr O. Klotz, who died in December last.

WE learn that the Radio Society of Great Britain is in touch with the Postmaster-General regarding the restrictions as regards transmissions to the dominions and foreign countries recently introduced into the experimental transmitting licences now being issued. It is hoped that an official announcement may be made at an early date.

AT the annual general meeting of the Faraday Society held on July 7, Prof. F. G. Donnan was elected to succeed Sir Robert Robertson as president The annual report records considerable activity during the past year, the result of which is reflected in the accounts, which show a deficit of 109*l*. 11*s*. 5*d*. on the year's work. Eleven meetings were held during the year, and of these four were general discussions, which have become so striking a feature of the work of the Society The subjects of these were. (i.) "Alloys Resistant to Corrosion." (ii.) "The Physical Chemistry of the Photographic Process." (iii) "The Electronic Theory of Valency." (iv.) "Electrode Reactions and Equilibria" The widespread appreciation in which the publications of the Society are held is indicated in the fact that the sales of Transactions and reprints amounted to nearly 900*l*., a figure in excess of the amount received for subscriptions. It is surprising to note that the membership of this very active Society is only 432, and that consequently an appeal for a larger membership is made in the annual report. Particulars relating to the Society may be obtained from the secretary and editor, Mr. F. S. Spiers, 90 Great Russell Street, London. W.C.1.

IN commenting upon an article in NATURE of July 12 on "Artificial Daylight," a correspondent suggests that

the apparent indifference to daylight lamps is due to their excessively high prices. Our contributor, Dr. Martin, remarks that he has no knowledge of the actual cost of production, but he agrees that the average price appears to be high. Doubtless, however, an increased demand would cheapen production and result in lowered prices. The question is one with the general question of efficient lighting. To take an actual example, there are many days during the winter in which the grading and examination of such things as seeds, tea, tobacco, etc , is very difficult, if not impossible. There is no doubt that time and money are lost in this way for want of an efficient illuminant. The actual cost of a good daylight lamp would be negligible in comparison with the saving effected , that is, if the user trusted his lamp and the customer had been educated to the point of trusting it also

The following are among the pensions granted during the year ended March 31, 1924, and payable under the provisions of section 9 (1) of the Civil List Act, 1910· Mrs. C. A. F. Rhys Davids, in recognition of her contributions and those of her husband, the late Prof Rhys Davids, to the advancement of Pali and Buddhist knowledge, 100*l* ; Mrs. Blanche Hartog, in recognition of the contributions of her husband, the late Prof. Marcus Hartog, to the study of natural history, 50*l* ; Dr. Alice Lee, in recognition of her services to the cause of scientific research, 70*l.* ; The Misses Ethel Marian and Katherine Elizabeth Rivers, jointly and to the survivor, in recognition of the services rendered by their brother, the late Dr. W. H R. Rivers, to the cause of anthropology, physiology, and psychology, 100*l.* ; Mrs. M. F. Robertson, in recognition of the services rendered by her husband, the late Dr. W F. Robertson, to science and medicine, 100*l*.

Mr. F. Edwards, 83 High Street, Marylebone, has just issued Catalogue No 460 (British Empire Series, No. 3), containing the titles of upwards of 1100 works relating to India, Burma, Ceylon, Afghanistan, Beluchistan, Malaya, and Borneo. Many of the books listed formerly belonged to the late Dr. W. Crooke, a regular contributor to Nature.

We have received Bulletin 212 of the Department of the Interior, Washington, entitled "Analytical Methods for Certain Metals, including Cerium, Thorium, Molybdenum, Tungsten, Radium, Uranium, Vanadium, Titanium, and Zirconium," by R. B. Moore, S. C Lind, J. W. Marden, J P. Bonardi, C. W. Davis, and J. E Conley. The pamphlet is of great value and should be found useful by analysts. Many modern products (*e g* special steels) contain these so-called "rare" elements, and rapid and accurate methods for their estimation are required.

Our Astronomical Column.

Large Fireball.—On July 7, a few minutes after midnight, a splendid meteor was observed at various places. It appeared, however, at a time when few observers were about, and hence we are not likely to receive many accounts of it. The object gave a very vivid illumination for a few seconds and moved very slowly from a radiant very probably in Scorpio. The descriptions already to hand are not, however, sufficiently definite to allow safe deductions to be made from them From near Dunstable, the flight of the fireball was recorded as from κ Draconis to a little below α Aurigæ From near Ludgate Hill, London, the meteor appeared as a large ball of fire leaving a trail of white sparks. The nucleus was yellow in the central part and brilliant orange in the outer portion.

Observations of the position of the flight and its duration would be valuable Large meteors have often been directed from Scorpio in the three months May, June, and July, the radiant point being a few degrees N.E. of the bright red star Antares

August Perseids.—This annual display of meteors has already given clear evidence of its activity. Mr. Denning, writing from Bristol, states that he observed an early Perseid this year on June 27, when the radiant was in about $356°+39°$. From this point in Andromeda, the shower will move to E.N.E. through the northern region of Perseus and on between the constellations of Auriga and Camelopardalus. This stream of meteors has the longest duration of any known shower and the propriety of terming it "the Perseids" is perhaps questionable seeing that the meteors, during a portion of the shower's activity, diverge from Andromeda and other constellations.

Of late years this shower has formed some attractively abundant displays and notably so in 1921 and 1923. In the former year there was a decided maximum, the horary number reaching 250 for one observer on Aug 12 A.M. Coulvier-Gravièr, a great French observer of meteors in the first half of the last century, thought that, after a maximum which he observed in 1848, the strength of the display declined so rapidly that it would be extinct by the year 1860 His conclusions were, however, far from being realised, and the shower continues to be visible every year with apparently the same richness as it exhibited in former times.

The Canadian Eclipse Expedition to Wallal 1922.—C A. Chant and R. K. Young have just published the details of their investigation of the gravitational bending of starlight made at Wallal (Publications of Dominion Astrophys. Observ., vol. ii. No. 15).

An equatorial was taken, the general design of which is stated to resemble that of the 100-inch at Mt. Wilson. The total weight was about a ton. A guiding telescope of $4\frac{1}{2}$-inch aperture was attached to the camera, β Virginis being used for guiding. Two plates were taken for the Einstein investigation, each with 45 seconds exposure ; 20 stars are shown, the magnitudes of which range from 4·3 to 9·5, but the two faintest were not used.

Full details are given of the measurement and reduction. The adopted mean shift at the sun's limb is $1{\cdot}75''$, exactly agreeing with Einstein's value. The separate values for measures in the x and y coordinates are $1{\cdot}32''$, $1{\cdot}96''$.

The results are insufficient to *prove* that the individual shifts follow Einstein's law (shift varies inversely as distance from sun's centre) : but they group themselves fairly satisfactorily on either side of the theoretical curve.

The three separate investigations made during this eclipse all give mean results very close to Einstein's value.

Research Items.

ZENITH OF PRIMITIVE BABYLONIAN ASTRONOMY.—Prof. Reginald A. Fessenden, of Chestnut Hill, Mass., whose proposals for an archæological expedition to the Caucasus have received support from archæologists and ethnologists in the United States, including Prof. Clay of Yale, and Dr. A. Hrdlička, writes to ask whether any information is available in regard to a primitive Babylonian zenith fixed at Mt. Bakhar, near Baku. Prof. Fessenden is of the opinion that the zenith of primitive Babylonian astronomy, which goes back to a time when the Accadai (Agadi) had not yet descended from their mountain fastnesses, was fixed in the Caucasus. This area he maintains was the meeting-point of the original Babylonian and Egyptian civilisations. In support of this view he argues that the Book of the Dead was originally written in what Dr. Clay has called "Amuraic"—the early Semitic language—and that when it was translated into Egyptian, place-names were transformed and personal names mistranslated. When corrected in the light of a knowledge of the original tongue, these names reveal that the hidden land of Amen was the Caucasus Isthmus, for the road to which the Book of the Dead gave precise directions. The Egyptians and Colchians would thus be the same race, and the Isthmus the old home-land of the former. At the same time, many of the place-names in the neighbourhood of Mt. Bakhar, which antedate the Russian regime, are Babylonian, *e.g.* Schemacha, Marazi, Agadi-Kend, etc. It is therefore desirable to fix the zenith with some accuracy to determine which sites may be investigated by a preliminary expedition with most profit.

THE BLOW-GUN IN ASSAM.—In view of the frequent identity of culture between the Naga tribes and those of Indonesia, it has seemed rather surprising that while the blow-gun occurs among the latter, it should not have been found in Assam. Its occurrence is now recorded for the first time by Mr. J. H. Hutton in *Man* for July. It is found—as a toy rather than as a weapon—among the Thado Kukis, its principal use being to shoot rats. The darts are not poisoned. A similar toy is used in the Philippines; but the Karens of Burma, who appear to be related to the Nagas, employ the genuine blow-gun. The Thado type does not appear to be a degeneration, but is more probably the original form which in this area never developed. It consists of a single internode of simple bamboo, the maximum length being about two feet. It has an effective range of about twenty feet only, though a mere carry of seventy feet can be attained. Several patterns of dart are in use. In one of these, cotton is employed for the plug, although, it is interesting to note, this material does not occur in the area of distribution in Asia of the genuine weapon.

DIENTAMŒBA FRAGILIS IN A CHILD.—W. H. Taliaferro and E. R. Becker record (*Amer. Journ. Hygiene*, vol. iv., pp. 71-74, 1924) the case of a three-year-old girl, who was born in Baltimore and had never left the state of Maryland, infected with several intestinal protozoa, namely, *Dientamœba fragilis*, *Iodamœba williamsi*, *Endamœba coli*, *Trichomonas hominis* and *Giardia lamblia*. The child had never suffered from any intestinal disorder. Prolonged search failed to reveal any encysted stage of *D. fragilis*. The authors tabulate the 33 previously recorded infections with this species, the distribution of which indicates that, in common with other intestinal amœbæ of man, it is indigenous to the temperate zones as well as to the tropics.

DOUBLE EGGS.—Prof. T. H. Morgan contributes (*Scient. Monthly*, April 1924) a useful account of double eggs—twice as large as those normal for the species—which are supposed to arise from the union of two eggs. They develop into embryos twice as big as normal ones. The occurrence of these giant eggs has led to the attempt to unite two eggs by artificial means and to experiments on the fusion of blastulæ or parts of embryos. Prof. Morgan remarks that the results obtained from the study of fused eggs or embryos have not solved any of the larger problems of development, but have broadened our ideas concerning some of the possibilities of regulation between two systems each alone adjusted to produce only a single individual. He describes the recorded cases of the development of giant eggs of sea-urchins and the opportunity these have afforded for estimating the relative importance of chromatin and protoplasm in the development of hybrid larvæ. These giant eggs, the mode of origin of which is unknown, have a single nucleus with twice the normal number of chromosomes, and when fertilised develop at the normal rate. Large blastulæ and plutei are formed which have the normal number of cells, but the cells are twice the normal size. The normal egg of Sphærechinus contains, according to Baltzer, 20 chromosomes and after fertilisation 40; the fertilised giant egg contains, according to de Haan, 60-63 chromosomes, 40 of which probably come from the egg (diploid) and 20 from the sperm. An account is given of the hybrid plutei produced by fertilising giant eggs of Sphærechinus by sperm of Strongylocentrotus, and the stronger resemblance to the maternal plutei is probably due to the greater influence of the larger number of maternal chromosomes. Double-sized eggs of Ascaris and giant embryos of Lineus and of Triton arising from the fusion of two eggs are described and discussed, and reference is made to the origin of embryos which are not giants, but nevertheless apparently owe their origin to the fusion of two eggs (*e.g.* in a strain of Abraxas).

ICEBERGS IN NORTH ATLANTIC.—A descriptive account of the dangers of ice to vessels traversing the ocean between Europe and America, and the effective means taken to avert the danger, is given by Prof. R. de C. Ward, of Harvard University, in the *Monthly Weather Review* for February. A cruise, lasting fifteen days, was made on the U.S. Coast-guard cutter *Modoc*, on ice patrol duty, and the author being a meteorologist of great experience his communication is greatly enhanced. A memorial service was held at the spot where the *Titanic* sank, after collision with an iceberg in 1912, when 1500 lives were lost. The danger zone is now patrolled day and night during the ice season, the position of menacing bergs is given by radio to all passing ships, and no serious collision with ice has occurred since the patrol was inaugurated, a month after the catastrophe to the *Titanic*. Every vessel passing through the ice region, longitude 43° to 55° W., is expected to send by radio to the patrol vessel information as to any ice sighted. The U.S. Government manages the service, other nations assuming a share of the expense. Most of the bergs come from the fringe of glaciers bordering the west coast of Greenland, east of Baffin Bay, others come from the east coast of Greenland, and some start in Smith Sound. Charts are given showing the general drift of icebergs, and the drift track of an iceberg in the season of 1921 is shown, being traced from April 11 until May 12. Hunting icebergs is the business of the ice patrol, and the commanders of the vessels

employed are highly experienced. Photographs are given of several bergs. Testimony is borne to the splendid work done by officers and men, year after year, amid the dangers of ice, fog, and storm.

THE FATIGUE OF METALS.—Profs. H. F. Moore and T. M Jasper have just published the third portion of their extensive research into the fatigue of metals as Bulletin No 142 of the Engineering Experiment Station of the University of Illinois. On re-testing wrought specimens of iron and steel which have been subjected to many millions of stress alternations without failure, it is found that their endurance has been increased, the strengthening effect being greatest in those steels which are most hardened by cold-working The static strength is also increased Alternating stress above the endurance limit, on the other hand, weakens the metal, although the bad effect may be partly removed by polishing Reversed axial stresses give an endurance limit which is only about 64 per cent. of that found by alternating bending tests, but this difference has not always been found by other investigators, and may perhaps be due to the form of test-piece employed. The authors consider that their test-piece represents the conditions likely to occur in the actual running of machines, and therefore recommend the adoption of the lower figure for reversed axial stresses. This recommendation may lead to controversy. Steels give inferior tests across the direction of rolling, as would be expected, and it is interesting to note that the cross tests are more improved by heat treatment than the longitudinal tests. It is doubtful whether soft non-ferrous metals and alloys have an endurance limit, and in order to determine this point it will be necessary to continue the tests for hundreds of millions of cycles. The authors take the view that fatigue failures do not take place by slip, but by the tearing apart of minute portions of crystals and spreading of the fissures so formed.

FIBROUS STRUCTURE IN METALLIC ELECTROLYTIC DEPOSITS —Messrs R. Glocke and E. Kaupp have recently carried out an X-ray examination of electrolytically deposited metals, which they describe in the *Zeitschrift für Physik* for May. They find it advantageous to use homogeneous radiations of medium wave length, the best results being produced by using an anticathode made of a metal closely following silver in the periodic system, the natural radiation of which excites the silver radiation of the photographic granules. An alloy of antimony and nickel (63 : 33), which melts at 1158°, a temperature nearly twice as high as the melting-point of pure antimony, was experimented with, and appears to be suitable, but the actual measurements were made with a silver anticathode X-ray photographs were taken in a number of different directions through the material used, and showed that, in many cases, there was a distinct fibrous arrangement of the crystals. The axis of the elongated crystalline "fibres" is in the [011] direction in the case of copper, in the [111] or [112] direction for iron, [001] for nickel and [112] for chromium. In all cases this axis is identical with the direction of the electrolysing current, or perpendicular to the cathode surface. The crystallographic direction of the axis of the fibres depends on the composition of the solution; and, with some solutions, there is no fibrous structure, but the crystals are small and granular. It appears that the fibre axis is the direction of maximum growth velocity of the particular crystal in the electrolyte concerned. The nature of the cathode influences the structure, which is most perfectly fibrous when the cathode and the deposit are of the same metal.

DRY COOLING OF COKE IN GASWORKS PRACTICE.—Hot coke drawn from gasworks retorts is customarily cooled by contact with a stream or spray of water. At the newly erected Garston works of the Liverpool Gas Company the Sulzer system of dry cooling, now in operation at some continental works, has been tentatively applied to the coke derived from a bed of ten retorts, and the results were described at the annual meeting of the Institution of Gas Engineers. The coke so cooled is superior in appearance, higher in calorific power, and burns more freely in an open fireplace than that produced by wet quenching. The increased cost of dry cooling amounts to about 1*s.* 3½*d.* per ton of coke. Economic considerations indicate that the sale of dry coke is a sound commercial proposition provided the consumer realises the superior value of the dry fuel.

CHEMISTRY OF FATS —A large part of the presidential address delivered by Dr. E. F. Armstrong to the Society of Chemical Industry on July 9 in Liverpool was a joint communication with Mr. John Allan dealing with our present knowledge of fats. After dealing with the composition and constitution of the natural glycerides, the authors emphasise the need for further research on the separation of certain fats which resemble one another closely in chemical composition, but differ widely in physical properties. They describe fully how the fatty acids are distributed in Nature, and indicate their possible modes of formation. They think that fats may be synthesised in plants and in animals from carbohydrates, of which the unit is one containing 18 carbon atoms in its molecule. Milk fats and certain nut oils may be built up from a simpler carbohydrate, like dextrose, the contained acids being synthesised from one another by repeated aldol condensations; and a third possible mode of synthesis is by resolution of dextrose into a C_3-unit and condensation of such units to form acids containing 12 or 18 carbon atoms.

SYNTHESIS OF METHANE FROM WATER GAS.—From work carried out in the laboratories of the South Metropolitan Gas Company and communicated to the annual meeting of the Institution of Gas Engineers, it appears that the reaction velocity of the synthesis of methane from water gas at 290° C. is increased about seventeenfold by the use of an activated catalyst, namely nickel-thoria, in place of nickel. The technical application of the process requires practically complete removal of sulphur compounds from the water gas employed, as it is found that one part of sulphur per million parts of gas effectively poisons the catalyst. Such removal and the necessary adjustment of the hydrogen to carbon monoxide ratio in the water gas can be effected smoothly and rapidly at temperatures industrially applicable, namely, about 550° C., by the passage of water gas and steam over a catalyst consisting of iron activated by chromium oxide deposited on five times its weight of pumice. Excluding the cost of this hydrogenation process, it is estimated that the net cost of production of a synthetic gas of approximate composition CH_4, 64 per cent.; H_2, 24 per cent.; N_2 12 per cent., and of calorific power 690 B.Th.U. per cubic foot, would be 10·9*d.* per therm. The cost of removing carbon dioxide appears to be the deciding factor as regards the possible establishment of the process on an industrial scale. (Cf. NATURE, June 9, 1923, vol. 111, p. 779.)

The Toronto Meeting of the British Association.

Provisional Programmes of Sections.

PROVISIONAL programmes of the Sections of the British Association for the Toronto meeting on August 6-13 have now been arranged, from which it appears that those who attend the meeting will be very fully occupied. The meeting will be noteworthy for the number of American and Canadian men of science who are presenting papers and taking part in many of the joint discussions.

We are indebted to the Recorders of the Sections for the following brief statements of important features of the work of the various Sections.

Section A (Mathematics and Physics).

The outstanding feature of an extensive programme is the discussion which has been arranged, jointly with Section B, on crystal structure The presidential address which Sir William Bragg will deliver on "The Analysis of Crystal Structure by X-rays" will form the introduction to this discussion, to which, among others, Prof. W. L. Bragg, Prof. S Chapman, Dr. Shearer, Prof. Desch, and, possibly, Prof Siegbahn (of Upsala) will contribute.

The exceptional equipment of the Toronto physical laboratory lends special interest to the paper promised by Prof. McLennan on "Recent Developments in Low Temperature Research," because the liquefaction of helium and the luminescence of solid nitrogen will be demonstrated. The United States, as well as Britain and Canada, will be well represented in the programme; the papers by Drs. Mohler and Foote on "Critical Potentials and their Interpretation," Prof. A. H. Compton on "The Quantum Theory of the Scattering of X-rays," Prof. Duane on "Secondary and Tertiary Radiation," and one by Prof. R. W. Wood may be mentioned.

Among the visitors to Canada, Prof. A. Fowler will read a paper on "The Spectra of Ionised Elements," Mr. R. H. Fowler will deal with "Mechanisms of Excitation, Ionisation, and Dissociation in Statistical Theory," and Prof. C. V. Raman will take a principal part in a discussion of the scattering of light.

There are many meteorological and geophysical papers promised, and the Section will have to subdivide in order to deal with them. Sir Napier Shaw has chosen the subject "If the Earth went Dry," and Mr. F. J. W. Whipple and Mr. L. F. Richardson, who are also going from England, will read papers. Canada itself is providing a number of meteorological papers; Sir Frederic Stupart, the Director of the Canadian Meteorological Office, has given as his subject "The Variableness of Canadian Winters." Astronomy will occupy a whole morning; papers are expected from Prof. Eddington on "Theory of Outflow of Radiation from a Star," Dr. H. H. Plaskett on "The Spectra of Nebulæ," and Dr. Silberstein on "Determination of the Curvature Radius of Space-time."

A special feature is being made of afternoon sectional lectures, of which there will be no less than three, and those of exceptional interest. Sir Ernest Rutherford will lecture on "Atomic Disintegration," Sir Richard Paget on "The Nature of Speech," and Prof. V. Bjerknes (of Bergen) on "The Forces which lift Aeroplanes." The last two will be illustrated by experiments. It is hoped to arrange short sessions of the Section at Saskatoon and Edmonton during the transcontinental excursion following the Toronto meeting. Sir Richard Paget has promised to lecture at both places.

Section B (Chemistry).

Chemistry will be represented by a good attendance from Great Britain, and interesting meetings are expected. The president, Sir Robert Robertson, has selected "Chemistry and the State" as the subject of his address, and he will also deliver a lecture on explosives. The Section will join with Section A (Mathematics and Physics) in a discussion on crystal structure, and with Section I (Physiology) in one on vitamins, particulars of which will be found under the programmes of those sections. A morning will be devoted to a discussion on electrochemical industries, with special reference to Canada, Mr. H. Freeman dealing with Canadian hydro-electric development, Mr. D. A. Pritchard with the Canadian Salt Co.'s processes, Mr. R. L. Peek with electrolytic nickel, Mr. F. A. J. Fitzgerald with a radiant resistor furnace, and other contributors being Mr. F. A Lidbury and Prof. F. G Donnan.

Section C (Geology) will join in a discussion on liquid and powdered fuels, Dr. G. S. Hume reviewing the liquid fuels of Canada, Prof. G A. Guess describing the use of powdered fuel in metallurgical plants, and Prof W. A. Bone that of Canadian lignites. In another session, Prof. Bone will deal with the activation of nitrogen in explosions. An important discussion, in which Section A will join, is that on colloids, which will be opened by Prof. J. W McBain with a group of papers dealing mainly with soaps, whilst Prof. W. D. Bancroft will speak on the permeability of membranes, Prof. E. F. Burton on the mutual action of electrically charged particles in solution, Prof. W. Lash Miller on the distribution of colloidal gold between two liquid phases, Prof. F. B. Kenrick on colloids in distilled water, and Prof. H. S. Taylor on adsorption from silver salt solutions by silver iodide. Visits to electrochemical works are being arranged.

Section C (Geology).

Ontario, one of the most important mineral-producing areas in the world, must of necessity be intensely interested in geological problems, and no gathering of men of science there could possibly avoid devoting considerable attention to that branch of science While general topics are of interest in any or all circumstances, the industrial applications of geological knowledge are of paramount importance here. In addition, it is not without advantage that the problems confronting geologists and mining men in Canada are largely connected with the most ancient rocks of which we have any knowledge. Consequently the programme of Section C has been designed to stimulate, so far as possible, interest in both pure and applied geological science. The president, Prof. W. W. Watts, has selected as the subject of his address "Geology in the Service of Man," while subsequent speakers will emphasise particular aspects of applied geology as evidenced in Canada, and more especially in Northern Ontario. Inextricably bound up with the practical side of geology in Canada are the various problems connected with Pre-Cambrian rocks (indeed the word Pre-Cambrian is almost a household word in Ontario), and a whole session will be devoted to consideration of problems associated with these rocks in many parts of the world.

Appealing more strongly perhaps to another group of the public will be the joint discussion with the geographical section on changes of sea-level in relation to glaciation, coast-lines, etc., while a third on liquid and powdered fuels has been arranged as a joint discussion with Section B (Chemistry). This latter has had to be fixed to run concurrently with another meeting as the time available will not suffice for all the activities of the Section.

While such questions of general interest will occupy a considerable part of the sessions, the results of recent research work on more special subjects will be expounded by many authors. Mineralogy, petrology, palæontology, and stratigraphical geology will all be represented, so that every branch of geological interest will have its exponents.

As is usual in the case of Section C, excursions to places of interest round Toronto will form an important part of the programme. Three such excursions have already been settled, one being a week-end trip to the Niagara and Grimsby districts. Others will probably be fixed during the meeting, and members are advised to consult the notice boards outside the sectional rooms from time to time On the western trip following the meeting, opportunities will be given for geologists to examine selected areas *en route*, but such areas must of necessity be determined by factors not entirely geological.

SECTION E (GEOGRAPHY).

The address by the sectional president, Prof. J. W. Gregory, will deal with "Inter-Racial Problems and White Colonisation in the Tropics" Another paper on allied problems will be on "Immigration from a Biological Point of View" by Dr. H. H. Laughlin Many of the papers will treat of various aspects of Canadian geography, including Dr Bell Dawson on "Tides and Currents in Canadian Waters," and Mr E. M. Dennis, Mr. W H. Boyd, Mr. N. Ogilvie, and Mr W. H. Herbert on different branches of the work of the topographical survey of Canada. Dr. R. M. Anderson will speak on the status and prospects of the larger mammals of Canada.

Papers dealing with cartography and allied problems will be given by Mr I. Bartholomew on modern developments in the construction of maps and Mr. J. B. Reynolds on the work of the Permanent Committee on Place-Names. Important papers in physical geography include "Wind, Wave, and Swell in the North Atlantic" by Dr. Vaughan Cornish, "Classification of Oceanic Islands" by Prof. W. M. Davis, and "The Glacial Anticyclone" by Prof W. H. Hobbs. Prof. P. M. Roxby will lecture on the distribution of population in China, and Mr. Cuthbert Christy on Cape to Cairo progress.

Papers in human geography also include one on some aspects of urban growth by Mr H. L. Seymour, and another on the influence of geographic conditions on the ancient Mediterranean religions by Miss E. C. Semple. Miss M. I. Newbigin's paper on the training of the geographer should direct attention to the notable lack of such facilities in Canada

SECTION F (ECONOMIC SCIENCE AND STATISTICS).

The programme for the Economics Section at the Toronto meeting covers a wide and important field. Sir William Ashley's presidential address is "A Retrospect of Free Trade Doctrine." Business forecasting will be discussed by Prof. W. N. Persons, Mr. R. H. Coates, Prof. Mitchell, and Prof. H. W. Mackintosh.

The problem of population is to be dealt with in four papers from different points of view; Sir William Beveridge dealing with the fall of human fertility among the European races, and some of its reactions, Mr. Udny Yule with the population problem from the point of view of the Pearl and Reed law of growth, Prof. MacIver with civilisation and population, and Prof. Field with eugenic worth and economic value. Prof. J. E. Boyle is contributing a paper on the marketing of grain, and a film is to be shown illustrating the marketing of wheat. A discussion is to be held jointly with the Agriculture Section on diminishing returns in agriculture, and papers are to be read by Prof. C. R. Fay and Sir John Russell Prof. A. L. Bowley will read a paper on the economic outlook in Great Britain, and the problem of unemployment prevention and insurance is to be discussed in papers by Prof. J. R. Commons and Mr. Bryce M. Stewart.

The meetings of the section will, therefore, bring together many of the leading economists of Great Britain, Canada, and the United States.

SECTION G (ENGINEERING).

The programme of the Section opens with Prof. G W. O. Howe's presidential address entitled "One Hundred Years of Electrical Engineering." The remaining papers to be presented fall practically into two big groups: Canadian engineering problems and the strength of materials.

The first group is to be opened by Sir Henry Thornton, president of the Canadian National Railways, who will discuss railway transportation in Canada. This will be followed by a paper from Lieut-Col. H. S. Lamb on engineering problems and traffic on the Great Lakes. Mr. J B. Challies, director of the Water-Power and Reclamation Service, is to deal with the water-power resources of Canada. Water-power development commenced in 1895, and its possibilities may be envisaged from the fact that during the past ten years, while the population has increased 22 per cent., the water-power in use has increased nearly 100 per cent, and its use in industry 245 per cent. The total water-power of the Dominion is estimated at 18,000,000 horse-power, of which nearly 3,250,000 horse-power has been developed and 750,000 is under construction. The story will be taken up by Mr. F. A. Gaby, chief engineer of the Ontario Hydro-Electric, who will deal with the Hydro-Electric Power Commission of Ontario, and by Mr. R S. Lea, who will discuss the possibilities of power development of the St. Lawrence River. A visit to the Niagara Fall Power Houses will be an appropriate conclusion to this part of the Section's work.

The second part of the programme will be opened by Prof. E. G Coker with Mr. A. L. Kimball, of the General Electrical Company, Schenectady, who will describe American experiments on the optical determination of stress. Profs. H. F. Moore and T. M. Jasper, of Illinois University, will discuss the evidence for the existence of an endurance limit in metals, Prof. F. C. Lea, the effect of high temperature on the range of repetition stress for steels, and there are several other papers on related topics. The whole subject may be expected to be dealt with in two reports to be presented to the Section, one by Prof. C. F. Jenkin, on the work of the Fatigue Panel of the Aeronautical Research Committee, and another on the work of the Complex Stress Committee.

Other subjects to be dealt with by the Section include questions of public health (Mr. F. A. Dallyn), bio-aeration in sewage disposal (Mr. J. D. Watson), cobalt magnetic steels (Mr. E. A. Watson), and the future of power from fuel (Mr. E. K. Scott).

SECTION H (ANTHROPOLOGY).

Communications by anthropologists from Canada and the United States provide the greater part of the programme of the Section. Dr. F. C. Shrubsall's presidential address is entitled "Health and Physique through the Centuries." Other British contributions will include papers by Dr. A. C. Haddon on "A Suggested Arrangement of the Races of Man"; Dr. T. Ashby on "Recent Archæological Discoveries in Italy"; Mr. H. Balfour on "The Welfare of Primitive

Peoples," and also on "The Art of Stencilling in the Fiji Islands"; Mr. L. H. Dudley Buxton on "Skulls from the Valley of Mexico," and on "Physical Observations on Navajo Children." Prof. H. J Rose's paper, "The Bride of Hades," will deal with virgin sacrifice as a fertility rite in early Greece and Rome.

Of communications by Canadian anthropologists, a number will deal with work which has been done under the Anthropological Department of the Geological Survey. Mr. Jenness deals with "The Ancient Education of a Carrier Indian"; Mr. T F McIlwraith with "The Potlach in Bella Coola," the result of a personal and, possibly, a unique experience, Miss E. G. Spier will analyse the "Ceremony of the First Salmon," and Mr G. E. Rhoades will discuss "Composition in the Art of the North-west Coast Indians" From the United States Dr. A. Hrdlička will discuss the antiquity of man in America in the light of recent discoveries, with special reference to the skeletal remains recently found at Los Angeles. Mr. B. Oetteking also will give an account of the Santa Barbara skeletal remains, and Mr Harlan I. Smith will describe "Trephined Aboriginal Skulls from Columbia and Washington" Dr C Wissler will deal with "The Segregation of Racial Characters in a Population," and Dr. Laughlin, of the Statistical Bureau, New York, will give an account of some racial characters emerging from the data obtained from immigrants. A joint discussion with Section J (Psychology) on "Racial Mental Differences" will be opened by Prof. W. McDougall.

Section I (Physiology).

The provisional programme arranged for the Section is the largest there has been for many years. It contains more than forty communications, covering a very wide range of subjects in physiology, biochemistry, and practical applications of these subjects to medicine.

The proceedings of the Section will open with the address of its president, Dr. H. H. Dale, on "Progress and Prospects in Chemotherapy." There are two joint discussions on the programme, one with Section B (Chemistry) and one with Section J (Psychology). The joint discussion with Section J will be on "Physiological and Psychological Factors of Muscular Efficiency in Industry," and will comprise the following papers among others · Prof. C. Lovatt Evans, "The Physiology of Muscular Contraction in Relation to Efficiency and Fatigue", Prof. E. A. Bott, "Co-ordinate Volitional Action of Antagonistic Muscular Groups"; Prof. E. P. Cathcart, "Energy Exchange in Relation to Muscular Performance in Laboratory Investigations"; Prof. C. S. Myers, "Conceptions of Fatigue," and Prof. F. S. Lee, "Physical and Chemical Tests for Fatigue."

The joint discussion with the Chemistry Section will be entitled "Vitamins, and the Relation of Light to their Action," and the following are included in the papers to be contributed to it: Prof. J. C. Drummond, "Modern Tendencies of Vitamin Research"; Prof. H. C. Sherman, "The Quantitative Distribution and Nutritional Significance of Fat-soluble Vitamin"; Prof. Walter H. Eddy, "The Isolation of a Bios from Autolysed Yeast"; Prof. E. Mellanby (title not given); Prof. W. Lash Miller, "Bios", and Prof. W. Steenbock, "Radiant Energy as the Anti-rachitic Factor."

Meeting at Toronto, it is appropriate that the Section should hear something of insulin, and Prof. J. J. R. Macleod and Mr. C. H. Best are, among others, dealing with this interesting subject.

Prof. J. C. Drummond is to deliver a popular lecture on "Cod-liver Oil."

There will be a large number of United States visitors at the Physiology Section.

Section J (Psychology).

The papers this year are so diverse in character that it is difficult to group them all under a few general headings. The presidential address by Prof. W. McDougall is entitled "Purposive Striving as a Fundamental Category in Psychology."

Three joint discussions have been arranged: (*a*) With Section H (Anthropology), on "Racial Mental Differences." *Speakers*—Prof W. McDougall, Dr. C. S. Myers, and others. (*b*) With Section I (Physiology), on "Physiological and Psychological Factors of Muscular Efficiency in Industry." *Speakers*—Prof. Lovatt Evans, Prof. E. A. Bott, Prof. E. P Cathcart, Dr. C. S. Myers, Prof. F. S. Lee. (*c*) With Section L (Education), on "Tests for Scholarships and Promotion." *Speakers*—Principal E Barker, Prof. C Burt, Prof. Sandiford, Prof. Whipple, and Prof Buckingham.

A welcome feature of the programme is the important contributions of American and Canadian psychologists, for example, "The Problem of Personality," by Dr. Morton Prince, and "The Value of Mnemic Psychology for the Interpretation of Dreams and other Phenomena," by Prof G. S. Brett, the local vice-president of the Section. A new feature is an informal conference of experimentalists on laboratory and applied researches, to be held on Saturday morning, August 9, Dr. C. S. Myers presiding, when several American, Canadian, and British representatives will exchange views.

Individual papers by British psychologists are: "The 'Self' in Cognition—Intuition, Concept, and Sensory Percept," by the Rev. F. Aveling; "Binocular Vision and Correct Ocular Muscle Balance: its Importance in Every-day Life," by Wing-Commander E. C. Clements; (1) "Psychological Theories of Laughter," (2) "Conscious and Unconscious in Psychology," by Dr. J. Drever; "Feeling and Emotion in Daily Life," by Mr. J. C. Flugel; "The Psychology of Déjà Vu," by Dr. J. T. MacCurdy; "Privileges and Limitations of Visual Imagery," by Prof. T. H. Pear, and "Shape-qualities or Relations?" by Prof. C. Spearman.

Section K (Botany).

The programme of the Section is noteworthy for the time which is to be devoted to discussions, either within the Section itself or in conjunction with other Sections. The proceedings start with a discussion on the ascent of sap and transport of food materials in trees, which will be opened by Prof. H H. Dixon: other speakers will include Dr. O. F. Curtis, of Cornell University, Dr. D. F. MacDougal, Prof. V. H. Blackman, and Prof. J. H. Priestley. Another sectional discussion is to be on Canadian forest problems: the speakers at this meeting include Mr. D. Roy Cameron and Dr. J. M. Swaine, who will deal with forest protection in Canada from fire and insects respectively; Mr. E. H. Finlayson on Canadian silviculture, Dr. A. W. Borthwick on the cultivation outside Canada of Canadian trees, and Messrs. R. D. Craig and F. Storey on world timber supplies.

Joint discussions have been arranged with the Sections of Agriculture and Zoology respectively. At the former, the subject will be "Forest Problems," and four papers on aspects of forestry in the United States and in Canada will be contributed by Mr. J. W. Toumey, Mr. R. D. Craig, Prof. J. H. Faull, of the University of Toronto, and Mr. E. J. Zavitz. This discussion, by representatives from two of the greatest timber-producing countries of the world, should prove of great interest and importance. The

joint meeting with Section D (Zoology) will be to discuss the subject of "Species and Chromosomes." It will be opened by Prof. R. Ruggles Gates, and other speakers are Dr. H. Harrison, Prof. T. H. Morgan, of Columbia University, Mr. Julian Huxley, Miss K. Blackburn, and Mr. A. D. Peacock.

Prof. V. H. Blackman's presidential address to the Section will be entitled "Physiological Aspects of Parasitism." Of the numerous papers to be presented, it is impossible to mention more than a few. Contributions from the North American continent include papers on the "black dot" disease of potato, by Prof. B. T. Dickson, on the fluorescent pigments of the Cyanophyceæ, by Prof. F. E. Lloyd; on the distribution of potassium in plant tissues, by Miss E. S. Dowding; on the status of the biogenic law, by Prof. E. C. Jeffrey; on the growth of British Columbia trees, by Prof. A. H. Hutchinson; and on the behaviour of chloroplasts and other cell contents at low temperature, by Prof. F. J. Lewis. A number of papers will also be presented by British botanists.

SECTION L (EDUCATIONAL SCIENCE).

The Section is to open its session with a paper on the teaching of history and geography of the British Empire by Prof. G. M. Wrong, of the University of Toronto, followed by a paper on modern tendencies in the teaching of geography, by Mr Ernest Young. The presentation of the Report of the special committee appointed last year to inquire into the educational training of boys and girls in secondary schools for life overseas will be followed by a discussion on the subject to be opened by Sir John Russell.

On the second day Principal Ernest Barker will deliver his presidential address, the subject being the "Nature and Conditions of Academic Freedom in Universities." Mr. A. E Heath, of the University of Liverpool, will follow with a paper on "Modern Developments in the Method and Scope of Adult Education." A joint discussion with Section J (Psychology) on the subject of "Tests for Scholarships and Promotions" will occupy the third morning; the chief speakers will be Principal Barker, Prof. Cyril Burt, Prof. G. M. Whipple, Prof B. R. Buckingham, and Prof. Sandiford. The latter in conjunction with Messrs. Brennan and Holmes will also contribute a paper on "The Use of Partial Coefficients of Correlation in Educational Research."

A discussion on "Modern Developments in Science Teaching" is to be opened by Mr. C. M. Stuart, late headmaster of St. Dunstan's School, Catford. Prof. J. L. Myres will read a paper on the place of classics in a secondary school system, to be followed by Mr. A. H. Hope, headmaster of Roan School, Greenwich, on the present position of classics in French secondary schools. The fourth morning will be devoted specially to subjects of Canadian interests. Sir Robert Falconer, president of the University of Toronto, will read a paper on "The Canadian University"; the Hon. Dr. H. J. Cody on the administration of education in Canada; Prof. G. M. Weir on an educational experiment in rural Saskatchewan; Dr. S. B. Sinclair on the selection of pupils for auxiliary classes; and Major J. B. Cowles on the working of the Adolescent Education Act in Ontario.

SECTION M (AGRICULTURE).

The meetings of Section M will be held under the presidency of Sir John Russell, the director of the Rothamsted Experiment Station, whose address on "Combination in tackling Farmers' Problems" will be given on Monday, August 10.

The proceedings on Thursday, August 7, will be opened by a short address by the Hon. J. S. Martin, Minister of Agriculture for the Province of Ontario. He will be followed by Dr. F. T. Shutt on "The Influence of Cropping on the Nitrogen and Organic Matter Content of Western Prairie Soils." Mr. H. J. Page, the head of the Chemical Department at Rothamsted, will read a paper on "Nitrogen Balance in the Soil"; and he will be followed by Dr. Scott Robertson on "The Fertilising Effect of Rock Phosphate." The next morning will be occupied by a joint discussion with Section D (Zoology) on "The Soil Population." This will be opened by Mr. D. Ward Cutler. In the afternoon, Mr. J. B. Reynolds, the principal of the Guelph Agricultural College, will speak on "Agricultural Colleges in Canada."

On Saturday, August 9, Mr. R. A. Fisher, of Rothamsted, will read a paper on "The Incidence of Rainfall in Relation to the Wheat Crop," and later in the morning Dr McRostie will speak on "Forage Crops in Canada." The same day, Mr. Engledow will read a paper on "A Spacing Experiment with Wheat," which will terminate the day's proceedings.

On Monday, August 11, Mr. Godden will speak on the work which is being carried out at the Rowett Research Institute on the mineral requirements of farm animals, and Prof. Berry will follow with a paper on "The Chemistry of the Oat Crop." The afternoon will be occupied by a joint meeting with Section K (Botany) on "Forest Problems in Canada," to which Mr. Zavitz and Dr Faull are contributing.

On Tuesday, August 12, the whole morning will be devoted to a joint meeting with Section F (Economics), the subject for discussion being "Diminishing Returns in Agriculture" This discussion will be opened by Dr. C. R. Fay, and it is hoped that other speakers will include Sir John Russell, Lord Bledisloe, Sir Henry Rew, and Mr. Ashby.

The proceedings of the Section will conclude with a joint meeting on forestry with Section K, in which such subjects as forest protection in Canada, and the cultivation of Canadian trees in other parts of the world, will be brought forward.

After the conclusion of the meeting, several local excursions have been arranged, including a visit to the Agricultural College at Guelph.

Atoms and Ethereal Radiations.[1]

IN his first lecture the speaker, after outlining the steps by which he and his collaborators had succeeded in pushing the region of wave-lengths explored by mechanically ruled gratings down to 136 Ångstroms, presented the results which had very recently been obtained by Mr. I. S. Bowen and himself, through the analysis, with the use of high resolution, of the fine structure of these extreme ultra-violet lines.

Photographs were shown in which such a close doublet as the B_{III} line at 677 Ångströms was not only clearly resolved, but had its components so well separated that their distance apart, which amounted to but 0·15 Ångströms, could be measured with certainty to 0·01 Ångströms or better, and in which the seven components of the 834·0 line of oxygen were

[1] Abstract, prepared by the author, of three lectures delivered on June 16, 17, and 18, at University College, London, by Robert A Millikan, Director of the Norman Bridge Laboratory of Physics of the California Institute, Pasadena, entitled (1) "Filling in the Gap between X-rays and Light", (2) "Electronic Orbits in Atoms", (3) "The Penetrating Radiations of the Upper Air."

clearly obtained in orders as high as the seventh. This high resolution has made it possible for Mr. Bowen and the author to prove with certainty that in their "hot-sparks" in high vacua, they have succeeded in stripping all of the valence electrons from the series of atoms, lithium, beryllium, boron, carbon, nitrogen and sodium, magnesium, aluminium, silicon, phosphorus, sulphur, six electrons having been removed from the outer shell in the case of the atom of sulphur

As an illustration of the way in which this can be proved, as well as of the way in which the recently discovered laws of atomic mechanics can be beautifully verified, the lecturer took the case of the stripped boron atom B_{III}, the spectrum of which had not before been known. Mr. Bowen and he first predicted that if they had B_{III} in their source they should have a line at 2077·4 Ångströms. They arrived at this figure by dividing the corresponding line of lithium ($3d$-$4f$) by nine. They then set their spectrograph for this wave-length and obtained the predicted line—quite a strong one—at the accurately measured wave-length of 2077·79 Ångstroms. They next predicted a line ($4f$-$5f$) at 4500 Ångströms, and obtained it at 4499 Ångströms, or within one part in 5000 of the predicted wave-length. They next predicted two doublets ($2p$-$3d$) and ($2p$-$3s$), of the same frequency separation at 677 and 758 Ångströms, and found both of them in the positions predicted and with the same frequency separation precisely as their theory demanded, this separation agreeing, too, as it should, with that of the first line of the principal series of B_{III} ($2p$-$2s$) first accurately measured in this work. Photographs showing all these lines as doublets, with the correct separation, were shown

The speaker concluded his first lecture with the presentation of the proof, furnished by his slides, that the Moseley law of progression of frequencies with atomic number, discovered through the study of X-ray spectra, holds also in the region of optical wave-lengths, such as he has been studying with the aid of his mechanically ruled gratings. In particular he showed that the L_{I} levels of sodium, magnesium, and aluminium obtained from his "hot sparks" fall, along with that of neon, very accurately upon a Moseley line; also that the strongest L line of the foregoing elements can be plotted upon the same straight line with the corresponding lines obtained by Siegbahn with the elements down to copper; and that a like type of progression was found in the L spectra of the elements from neon down to lithium.

Thus, though the wave-lengths between the lecturer's lower limit of 136 Ångströms reached by grating spectroscopy, and Siegbahn's upper limit of 18 Ångströms, reached by crystal spectroscopy, had not thus far been directly obtained, yet this small remaining gap has been bridged over by the establishment of a common law, with the aid of which it is now possible to compute with certainty some of the most outstanding characteristics of the radiations which must fall in the as yet unexplored region. To this extent then, the gap between X-rays and light has already been completely bridged.

In his second lecture the speaker presented, in a series of tables, work of Mr. Bowen and himself, as yet unpublished, in which two other X-ray laws, namely, the *regular*, or relativity-doublet law, and the *irregular* doublet law were definitely extended throughout the whole field of optics. This extension has become possible because the foregoing series of stripped atoms gives the first opportunity to compare, *in the field of optics*, a fairly long series of atoms possessing exactly the same electronic structure, but in which the nuclear charge progresses by unitary steps. It is in general such a series of identical electronic structures which is dealt with in comparing X-ray spectra. Hence the possibility of a very precise comparison of atomic behaviour in the optical and the X-ray regions.

The definite extension by Mr. Bowen and the lecturer of the X-ray laws into the field of optics means unquestionably, to take a simple specific case, that in the second quantum state the so-called $2s$ terms in optics correspond exactly to the L_{I} terms in X-rays, the $2p_2$ terms in optics to the L_{II} terms in X-rays, and the $2p_1$ terms in optics to the L_{III} terms in X-rays Stated otherwise, if the L_{II} and L_{III} levels in X-rays represent a relativity doublet, as they have hitherto been supposed to do, and correspond therefore to two differently shaped electronic orbits, one a circle [2_2], and one an ellipse [2_1], then p_2 and p_1 in optics also represent a relativity doublet, and correspond to these same two orbits.

While from an experimental point of view this definite unification of optics and X-rays under a common set of laws (Moseley law, relativity-doublet law, irregular doublet law) must be regarded as a distinct step in advance, since it tends toward a simplification, for the purposes of prediction, of the whole subject, it nevertheless introduces a very serious difficulty into the present status of atomic theory. For it appears to force us to choose between two positions, either of which presents apparently insuperable obstacles.

If we retain the physical interpretation of the relativity-doublet formula—a formula which is derived without the introduction of any arbitrary constant whatever from the theory of the change in mass with speed, and has had *quantitative* successes in interpreting the whole fine structure of the lines of atomic hydrogen and ionised helium—we must discard very largely the interpenetrating-orbit ideas with the aid of which Bohr and other workers have recently interpreted so successfully both optical and chemical phenomena. Specifically the difference between the energies of the so-called s and the p terms in optics can no longer be interpreted as due to the difference in the shapes of the $2s$ and the $2p$ orbits, the $2s$ corresponding to an ellipse, and the $2p_2$ and $2p_1$ to two circles. For if the relativity doublet interpretation is applied to the levels $2p_2$ and $2p_1$, one of these levels, namely $2p_2$, must correspond to an ellipse, while the other, $2p_1$, corresponds to a circle. *This requires that $2s$ and $2p_2$ be orbits of the same shape, namely, 2_1 orbits, despite their large difference in energy*

If, on the other hand, we retain the assignment of azimuthal and inner quantum numbers which has been universally made in recent years in the field of optics, and hence make the $2p_2$ and $2p_1$ levels correspond to two circles which differ slightly in energy because of a difference in orientation (inner quantum numbers), we are forced by the results herewith presented to treat L_{II} and L_{III} in the same way. This requires us to find some other cause than change of mass with speed to account for their observed difference in energy, which is, however, quantitatively accounted for by this so-called relativity-doublet theory.

Before the accumulation of the present data it was not so difficult as it is now to discard the relativity-doublet interpretation, but in this data the relativity-doublet formula has had new successes, for it fits satisfactorily with the behaviour of a whole group of atoms which pass over in successive stages toward the structure of atomic hydrogen and ionised helium. Thus there now seems to be no place to stop in discarding the relativity-doublet explanation short of abandoning *in toto* the idea of change of mass with speed in electronic orbits, and assuming that it was mere chance which caused this conception to lead to a formula which has had amazing successes, not

only in predicting exactly the fine structure of the hydrogen and helium lines, but also in explaining very beautifully the complexities of the Stark effect in these gases.

Such an assumption of accidental agreement where the relations are so beautifully quantitative and so numerous as they are here is one which the theoretical physicist will be very loath to make. The lecturer felt that further experimental data must be accumulated before a choice could with certainty be made between his alternatives. The present experimental situation, so far as the work of Mr. Bowen and himself are concerned, will be presented fully in forthcoming articles in the *Physical Review*.

In his lecture on the "Penetrating Radiation of the Upper Air," the results of the experiments made by Mr Bowen and the lecturer at Kelly Field, Texas, were described. They sent up sounding balloons carrying recording electroscopes, thermometers, and barometers to a height nearly twice as great (about 16 km.) as that reached in preceding studies of the penetrating radiation. The total weight of the whole apparatus sent up, exclusive of the balloons, was but 180 grams. The electroscope chamber consisted of an hermetically sealed, steel-walled vessel of about 200 cc. capacity, containing air at varying pressures ranging from 1 up to 11 atmospheres. Four such instruments had been sent up and three recovered, two of which had reached altitudes between 15 and 16 km, and both agreed in giving the integrated ionisation not more than 25 per cent of that obtained by extrapolation from Kolhörster's curves or computed from his 1914 absorption coefficient $\mu/D = 5 \cdot 77 \times 10^{-3}$ cm.^{2}/gm. These results showed quite definitely that no external source of radiation having the postulated characteristics existed. At the same time, they showed that the balloons in their ascent passed through regions in which the penetrating radiation was greater than its value at the earth's surface, since the integrated leak could not otherwise be greater than its value at the surface

Dr Russel Otis, of the California Institute at Pasadena, then checked these results by observations made in a number of aeroplane flights up to altitudes of 17,000 ft. In these flights he calibrated his electroscope at each particular level, thus rendering his results quite independent of any possible effects of temperature and pressure. He found, in agreement with Kolhorster, Hess, and others, that the penetrating radiation decreases slightly up to altitudes of six or eight thousand feet and then begins to increase. The actual values at 17,000 ft. (5·18 km.) were, however, but half those reported by Kolhörster at this altitude. Observations which Dr. Otis then made on Mt. Whitney at altitudes up to 13,000 ft checked quite well with those made in aeroplanes, thus indicating that the phenomenon is one due to altitude rather than to locality.

The most conclusive evidence as to the source of the radiation has come from a continuous series of night and day observations, inside and outside 5 cm. thick lead screens, which the lecturer and Dr. Otis carried out last September on the top of Pikes Peak (14,100 ft.) in Colorado. During these observations, as a result of a snowstorm, the ionisation inside the closed observing chamber dropped suddenly about 10 per cent., but when the test was made inside the chamber *when it was completely shielded by its 5 cm. of lead*, the percentage fall in the ionisation was about the same as in the unshielded chamber, thus indicating that *local causes* modified the ionisation which got through 5 cm. of lead as much as they modified that which did not have to go through such a screen. If a very penetrating radiation of cosmical origin existed, this should have been completely unmodified by local changes, so that the percentage change inside the shielded vessel should have been very much less than that observed when the shields were removed. This observation was, then, an indication that the whole of the radiation measured in the closed vessel was of local origin.

This indication was confirmed as follows. assuming, following Kolhorster's 1923 conclusions, a penetrating radiation of cosmic origin which produces 2 ions/cc./sec at sea-level, and has an absorption coefficient per cm. in water of $\alpha = 2 \cdot 5 \times 10^{-3}$, we find that this radiation would produce 6 ions/cc./sec. on top of Pikes Peak and 5·2 inside our lead shield We found that the ionisation in our chamber contributed by the walls and the lead shields was at least 7 ions, so that if there were no local radiation at all on Pikes Peak capable of getting through our screens, a condition contrary to fact, the lowest obtainable value of the ionisation inside our vessel should have been $7 + 5 \cdot 2 = 12 \cdot 2$ ions. *We observed directly* 11 *ions*. We conclude, therefore, that there can exist no such penetrating radiation as we have assumed

Our observations, therefore, seem to us to show that the whole of the penetrating radiation on top of Pikes Peak is of local origin. We have computed its absorption coefficient and find it but a little harder than that of the ordinary radioactive materials. How such quantities of radioactive material get into the upper atmosphere is as yet unknown.

University and Educational Intelligence.

Belfast—At the meeting of Senate of the Queen's University held on July 16, a letter was read from the trustees of the late J C. White intimating that they intended to hand over to the University a sum of 60,000*l*. Of this amount (1) a sum of 45,000*l*. is to be used in founding a professorship of biochemistry with a salary of 800*l*. per annum and equipping the department. (2) The remaining 15,000*l*. is to be used in founding a lectureship in bacteriology with a salary of 450*l*. and equipping the department. The title of the professorship is to be the "J C. White Professorship of Bio-chemistry," and the title of the lectureship the "J. C. White Lectureship in Bacteriology"

On July 17 the cheque for 60,000*l* was handed to the honorary treasurer of the University.

Cambridge.—The Local Lectures summer meeting will be held on August 1-21, and an attractive programme has been issued. The chief subject of study will be Egypt, its ancient, medieval, and modern aspects, and among the lecturers who have been secured are Sir Flinders Petrie, Prof. A. S. Hunt, Dr. A. H. Gardiner, Dr. A. M. Blackman, Dr. W. F. Hume, and Sir William Willcocks The group of lecturers on science include many of the leading scientific workers in the University, with the addition of Dr. Leonard Hill, director of the Department of Applied Physiology, Medical Research Committee, Prof. H. H. Turner of Oxford, and Dr. A. E. H Tutton. The inaugural address to the meeting will be delivered by Viscount Haldane. Further information can be obtained by application to Dr. Cranage, Syndicate Buildings, Cambridge; letters should be endorsed "Summer Meeting."

Edinburgh.—The following doctorates were conferred at the Graduation Ceremony on July 17, the subject of the thesis in each case following the name:—*D.Sc*: Mr. T. M Finlay, "The Old Red Sandstone of Shetland"; Dr. R. K. S. Lim, "Gastric

Secretion"; Mr. G. P. Douglas, "The Effect of High Tip Speeds on the Performance of Aeroplane Propellers"; D. Penman, (a) "Investigations relating to Temperature Conditions in Indian Mines and to the Explosibility of Indian Coal Dusts"; (b) Development of a Simplified View of Mine Ventilating Resistances, with Supplementary Papers." *Ph.D*: Mr. R. T. Dunbar, "Experiments on the Absorption of X-radiation of Short Wave-length, and on the Associated Scattered and Corpuscular Radiation"; Mr. D. A. W. Fairweather, "The Electrolysis of Salts of Alkyloxyacids"; Honor Bridget Fell, "Histological Studies on the Gonads of the Fowl"; Mr. R. E. Gibson, "The Electrolysis of a Mixture of the Potassium Salts of Acetic and Trichloracetic Acids and on the Nature of Kolbe's Electrosynthesis and Allied Reactions"; Mr. J. Haldane, "The Action of Diphenylformamidine on the Phenols"; Mr. J. H. Kenneth, "An Experimental Study of Effects and Associations due to Certain Odours"; Satis Ranjan Khastgir, "The Scattering of X-Rays and the J-Absorption Phenomenon"; Christina Cruickshank Miller, "Diffusion in Solution"; Mr. T. R. Paterson, "The Influence of Substitution on the Velocity of Reaction between Benzoic Anhydride and an Aliphatic Alcohol"; Mr. W. Robson, (a) "The Metabolism of Tryptophane—the Synthesis of Bz-3-Methyltryptophane; (b) "The Influence of Insulin on Acidosis and Lipæmia in Diabetes"; Mr. R. H. Slater, "The Influence of the Nature and Position of Atoms in Organic Compounds on the Reactivity of other Atoms in the Molecule. Polarity Effects in Aromatic Halogen Compounds", Mr. C. M. Yonge, "The Mechanism of Feeding, Digestion, and Assimilation in *Nephrops norvegicus*."

A Diploma in Technical Chemistry is now granted by the University to graduates of British or other approved universities who have taken a degree in science with honours in chemistry. The course of study for the Diploma extends over one academic year, and comprises instruction not only in technical chemistry but also in the elements of engineering practice, and in factory organisation and factory accounting.

Dr. D. Murray Lyon has been appointed Christison professor of therapeutics, in succession to Prof. J. C. Meakins.

Lieut.-Col. E. D. W. Greig has been appointed lecturer in tropical diseases. Lieut.-Col. Greig was formerly Director of Medical Research in India.

Among the recipients of the honorary degree of Doctor of Laws on July 17 were the following: Mrs. Sidney Webb; Mr. F. R. Jamieson, Senior Inspector of Schools; Sir David O. Masson, professor of chemistry at Melbourne; Prof. C. J. Martin, Director of the Lister Institute of Preventive Medicine; Prof. S. J. Hickson, of Manchester, Mr. G. G. Chisholm, formerly reader in geography at the University.

Dr. D. P. D. Wilkie, lecturer in clinical surgery, has been appointed to the chair of surgery for a period of ten years.

GLASGOW.—Mr. Hector J. W. Hetherington, principal of the University College of the South-West of England, Exeter, has been appointed to the chair of moral philosophy, in succession to Prof. Lindsay, now the Master of Balliol.

LEEDS.—Prof. J. B. Baillie, professor of moral philosophy in the University of Aberdeen, has been appointed Vice-Chancellor of the University, in succession to Sir Michael Sadler. Prof. Baillie was educated at Edinburgh, Trinity College, Cambridge, Halle, Strasbourg, and Paris.

MANCHESTER.—Mr. E. A. Milne, assistant director of the Solar Physics Observatory at Cambridge, has been appointed to the Beyer chair of applied mathematics.

ST. ANDREWS.—A letter was read from Prof. A. E. Taylor resigning the chair of moral philosophy in the University on his appointment to the chair of moral philosophy in the University of Edinburgh. The Court resolved to tender their congratulations to Prof. Taylor on his appointment, and to express their appreciation of the good fortune which has enabled this University to enjoy the benefits of his scholarship and share in his reputation for a fruitful period of sixteen years.

It was unanimously agreed to invite Mr David Morrison, lecturer in logic in the United College, St Andrews, and in University College, Dundee, to accept the vacant professorship as from October 1 next.

The Court resolved to appoint Dr. G. McOwan, assistant to the professor of chemistry, St. Andrews, to be lecturer in organic chemistry in the United College in succession to Dr. A. K. Macbeth, resigned. It was intimated that Mr. J. Stirling had resigned the post of assistant to the lecturer in botany in the United College, St. Andrews, on his appointment to a junior lectureship in the University of Liverpool. The Court approved the appointment of Mr. J. Duke Stewart as a tutor in anæsthetics in the University.

THE vacant principalship of the Northampton Polytechnic Institute, Clerkenwell, caused by the tragic death of Dr. R. Mullineux Walmsley in June, has been filled by the appointment of Mr. S. C. Laws, principal of the Wigan Mining and Technical College for the past nine years. The appointment is subject to the approval of the London County Council. Mr. Laws was educated at University College, Nottingham, and St. John's College, Cambridge, where he attended as an 1851 Exhibition research scholar and was admitted as an advanced student. He worked at Cambridge at the Cavendish Laboratory under Sir J. J. Thomson and received the special distinction of an extension of his scholarship for a third year, the University of Cambridge awarding him the certificate for distinguished research.

THE Universities' Library for Central Europe, established four years ago under the presidency of the late Viscount Bryce to meet the book-famine in the universities of central European countries, is appealing for funds to enable it to continue its work for at least another twelve months, after which it is anticipated that the economic conditions of those countries will have improved so as to render such external help less needful. The report of the executive committee for the two years 1922–24 shows that during that time 14,000 volumes and 25,000 periodicals were received by gift, and more than 1500 volumes by purchase. The presentations included several sets of NATURE and other journals. The number of consignments despatched were: To Austria 22, Czecho-Slovakia 37, Danzig 4, Finland 10, Germany 64, Hungary 10, Poland 19, Roumania 3, Russia 34. Among the subsidiary activities of the organisation may be mentioned: co-operation with the Vienna International Summer School and with the British Committee for aiding men of letters and science in Russia, and despatching French books to Paris for villages in the devastated areas. The honorary secretary is Mr. B. M. Headicar, of the London School of Economics. Contributions, which may be earmarked for any particular country or university, should be sent to Sir George S. Gibb, London School of Economics, Houghton Street, London, W.C.2.

Early Science at the Royal Society.

July 27, 1664. Ordered, That at the first opportunity Mr. Hooke be put to the scrutiny for the place of curator: That he forthwith provide himself of a lodging in or near Gresham College: And that these orders and votes be kept secret, till Sir John Cutler shall have established Mr. Hooke as professor of the histories of trades.

1681. The President [Wren], Mr. Henshaw, Mr. Colwall, Dr. Gale, Dr. Croune, Dr. King and Mr. Hooke were appointed a committee to go to Chelsea, and to meet at the Swan-tavern there at nine in the morning to speak with the Lord Cheney about inclosing the ground of Chelsea-college next the meadows.

July 28, 1670. The society thinking proper to discontinue their public weekly meetings, there was recommended to Mr. Hooke during this recess the care of these three things: 1. To continue to observe, whether there be a parallax in the earth's orb. 2. To observe the present variation of the needle. 3. To measure the quantity of a degree upon the earth.

1686. There happened much discourse about the way of preserving ships from the worms; and it was remarked, that sheathing with lead was the best expedient, and found to be so by the experience of Sir Anthony Deane; but that the carpenters opposed it as against their profit, affirming that the iron of the rudders so sheathed was more apt to be corroded

July 30, 1663. Christopher Wren to the president [Viscount Brouncker]—"The act and noise of Oxford being over, I retired to myself as speedily as I could, to obey your lordship, and contribute something to the collection of experiments designed by the society for his majesty's reception. The solemnity of the occasion, and my solicitude for the honour of the society, make me think nothing proper, nothing remarkable enough. It is not every year will produce such a master experiment as the Torricellian, and so fruitful as that is, of new experiments; and therefore the society hath deservedly spent much time upon that and its offspring. To produce knacks only, and things to raise wonder, such as Kircher, Schottus, and even jugglers abound with, scarce become the gravity of the occasion. It must therefore be something between both, luciferous in philosophy, and yet whose use and advantage is obvious without a lecture. . . . It is upon billiards and tennis-balls, upon the purling of sticks and tops, upon a vial of water, or a wedge of glass, that the great Des Cartes hath built the most refined accurate theories that human wit ever reached to. For myself, I must profess freely I have not anything by me suitable to the idea I have of what ought to be performed upon this occasion. . . .

1668. The experiment of shutting up two finches in two glasses of different capacity was tried. The vessels were closed with very good cement, the one containing about four and a half times the liquor of the other. The birds were both put in at the time of fifty-five minutes past four. That in the smaller glass appearing ready to die, after nineteen minutes, was taken out, but found dead. The other was kept in about an hour and twenty-eight minutes, and appearing to be sick, though not so very much so, was taken out, it being time for the society to rise; whereby it seemed, that the times and the quantities of the air necessary for respiration in these birds were almost in reciprocal proportion to one another.

August 1, 1678. Some mention was made of cures done by the natural heat of living bodies outwardly applied. Sir Christopher Wren observed, that the raising of a blister would cure the stinging of wasps. . . .

Societies and Academies.

LONDON.

Geological Society, June 25.—Dr. J. W. Evans, president, in the chair.—Miss M. E. **Tomlinson**: The river-deposits of the lower valley of the Warwickshire Avon; with an appendix by A. S. **Kennard** and B. B. **Woodward**. Fluviatile sands and gravels occur as river-terraces between Stratford and Tewkesbury. The surfaces of these terraces lie on curves parallel to the present thalweg of the Avon Five such terraces have been identified. No. 5 Terrace, the highest above river-level, has yielded no contemporaneous fossils. No. 4 and No. 3 both contain a warm fauna, with Hippopotamus and *Belgrandia marginata* occurring solely at No. 3 level, and *Corbicula fluminalis* at No. 4 level. No. 2 contains a cold fauna, with numerous remains of mammoth and *Rhinoceros tichorhinus*. No. 1 probably underlies the alluvium, and may be connected with the infilling of the buried channel which has been identified at Fladbury and Tewkesbury. The sole evidence of human industry found is a fresh flint of Mousterian type from No. 2 Terrace.—F. **Raw**: The development of *Leptoplastus salteri* Callaway, and of other trilobites (Olenidæ, Ptychoparidæ, Conocoryphidæ, Paradoxidæ, Phacopidæ, and Mesonacidæ). *Leptoplastus salteri* occurs in the Upper Tremadoc horizon of Shineton Brook (Salop). All stages of development are noted, except the protaspis. The development is divided into successive stages. The earliest stage has a long, simply segmented glabella; long pleural spines occur throughout the body, including three pairs on the head and four on the pygidium; while axial spines occur from the occipital segment throughout. In the last stage the glabella is short, conical, and smooth; of pleural spines, only the genal remain on the head, those in the thorax are reduced, and none remain on the pygidium, where axial spines are also wanting. With certain reservations, these four stages are also claimed to represent successive stages in the phylogeny. This ontogeny sheds much light on that of other trilobites. In the ontogenies of several families, it is the primitively posterior head-spines that at first are dominant—to be superseded later by the middle pair. In Mesonacidæ these again are succeeded by the anterior pair, which, in their lateral revolution, carried before them the anterior branches of the facial sutures, so that these cut the posterior border; they also stretched out the antero-marginal suture to the genal angle. These changes led to the supersession of the dorsal facial suture by the marginal suture, with consequent ankylosis along the former. The family is hereby claimed to have a head-structure not hitherto recognised. It illustrates a general principle—that those only of the cephalic sutures are retained as were necessary for ecdysis. The combined study of trilobite ontogeny and morphology strongly suggests, as Beecher claimed, that here the ontogeny extensively recapitulates the phylogeny; and therefore best indicates relationships. This indicates an early divergence in glabella-form, antedating divergences in cephalic spines and sutures Members of a "natural" order may, therefore, be expected to agree much more in glabella-form than in the cephalic suture, which has latterly been made the basis of classification.

Physical Society, June 27.—Mr. F. E. Smith in the chair.—O. W. **Richardson**: Thermionic emission from systems with multiple thresholds. The question of the connexion between thermionic emission and the internal electron levels of the emitting substance must be faced. The theoretical problem is attacked from

three different points of view, namely, (a) classical statistical mechanics, (b) chemical dynamics, and (c) the laws of photo-electric action. As a result it seems possible to exclude certain alternatives which might otherwise have appeared not improbable and to formulate a set of rules governing the fundamental phenomena which are not in conflict either with the known facts or with any well-recognised relevant principle.—F. C. **Toy**: *A selenium photometer.* The instrument was designed for use by photographic manufacturers in measuring the density of a negative after test exposures which vary from strip to strip of the negative. By means of a selenium cell, the intensities of two beams of light are compared, one of which passes through the part of the negative to be tested while the other passes through a compensating wedge which has to be adjusted until its effect on the second beam is equal to that of the negative on the first beam. As one beam is progressively obscured by one shutter, the other is progressively opened, the total illumination of the selenium cell remaining constant provided that the two beams on reaching it are of equal intensity. The method is extremely accurate.—L. **Hartshorn**: A method of measuring very small capacities. A bridge arrangement is described suitable for the measurement of very small capacities (of the order of 1 micro-microfarad and less) at telephonic frequencies. Means of securing (1) great sensitivity, (2) fineness of adjustment, and (3) elimination of capacities to earth and capacities due to the presence of connecting leads, are indicated, so that it is possible to measure the true inter-capacity between any two conductors, *e.g.* the electrodes of a thermionic valve. As a test of the method, it is used to measure the capacity between two steel balls of 1 cm. radius and at distances apart of 2·25 to 8 cm.—E. **Wilson**: A new form of string galvanometer. The magnets consist of two rings of cobalt chrome steel of 25 cm. diameter, the cross-section of the bar being 5 cm. × 1 cm. Each ring has an air gap of 0·1 cm., and the poles have a bevel of 45°, terminating in opposing faces of 0·4 cm. wide. The magnets are mounted one above the other, with their gaps in line, and a separation between the rings of 1 cm. The strings, two in number, are of platinum wire 0·002 cm. diameter, and are supported symmetrically in the gap by a brass former, the effective length of each string being 10 cm. —W. E. **Curtis**: The phosphorescence of fused transparent silica. A mercury lamp and a hydrogen tube, both of transparent silica, were used. Heat increases the intensity of the phosphorescence and decreases its duration. With helium containing a trace of hydrogen, it was found that whereas a condensed (oscillatory) discharge gave the Balmer lines faintly and feeble phosphorescence, an uncondensed (unidirectional) discharge developed neither Balmer lines nor phosphorescence. There was also a correspondence between the localisation of the Balmer lines and that of the phosphorescence. On admitting hydrogen to the helium tube by making it red hot, the phosphorescence was obtained strongly. The effect may be due to radiation of wave-lengths occurring in the hydrogen spectrum, but absent from the helium spectrum; the Lyman series of hydrogen, which lies between λλ 1,215-912 A, is probably the effective radiation.

Aristotelian Society, July 7.—Prof. T. P. Nunn, president, in the chair.—H. Wildon **Carr**: The scientific approach to philosophy. There are two problems of philosophy which are fundamental in their relation to present scientific research. The first concerns the biological sciences. It is the problem of the nature and genesis of the human intellect, whether it is essentially a cognitive faculty of receiving a revelation of reality by simple contemplation and natural reasoning, or whether it is a mode of cognitive activity produced in the evolution of life for a vital purpose, that is, to serve a special form of living activity. The second problem concerns the subject-matter of mathematics and physics. It is the problem of the subjective conditions of sense experience imposed on the observer of Nature, how far they must be held to qualify the objectivity of the results of observation and in what way they can be allowed for or abstracted from. Neither of these problems can be ignored by the scientific researcher, and both carry science beyond the realms of physics and biology into metaphysics and philosophy. The first is the leading motive in the philosophy of Bergson. The second is being forced on the attention of philosophers by the new principle of relativity of Einstein.

DUBLIN.

Royal Irish Academy, June 23.—Prof. Sydney Young, president, in the chair.—K. C. **Bailey** and Mrs. D. F. H. **Bailey**: The colorimetric estimation of thiocyanates and cyanates. The tests proposed by Spacu and by E. A. Werner for the detection of thiocyanates and cyanates respectively by the formation of coloured compounds with copper and pyridine are adapted to the colorimetric estimation of these substances. The estimation can be successfully performed in the presence of most common acids, bases and salts. Cyanates can be estimated thus in the presence of urea, but thiourea interferes with the estimation of thiocyanates.—J. J. **Dowling** and J. A. C. **Teegan**: Optical interference experiments with multiple sources. By the use of a train of two or more biprisms, multiple images of an illuminated slit are obtained. The resultant interference pattern has been observed corresponding to light sources arranged in any symmetrical formation. The fact that these sources do not lie in one plane introduces difficulties.

Royal Dublin Society, June 24.—Prof. J. A. Scott in the chair.—H. H. **Dixon**: Variations in the permeability of leaf-cells. With suitable arrangements, large changes in the electrical resistance of leaf-tissues may be shown to be associated with changes of temperature. Thus it may be inferred that the permeability of the component cells is doubled for a temperature rise of 10° to 30° C. Observations with specially constructed thermocouples show that leaves exposed to sunshine are often many degrees warmer than adjacent shaded leaves, and air-currents often lead to fluctuations of several degrees within a minute. Such temperature differences must give rise to alterations in the permeability of the cells. These permeability variations coupled with tensile stresses in the sap will lead to the transport of materials from the more permeable cells.

EDINBURGH.

Royal Society, July 7.—J. H. Ashworth, vice-president, in the chair.—D. H. **Scott**: Fossil plants of the Calamopitys type, from the Carboniferous rocks of Scotland. The stems of four plants are discussed. They are referred, provisionally, to the family Calamopiteæ, a group, placed among the Pteridosperms or "Seed-ferns" on the ground of anatomical characters. *Calamopitys radiata*, from the Cementstone group of Dumbartonshire, has pith that contains elements resembling tracheids, and may therefore have been a "mixed pith." The strands of primary wood surrounding the pith are large. The secondary wood is remarkable for the enormous width of many of the medullary rays, so that the woody zone consists largely of cellular tissue. This feature distinguishes the plant from all the other known species of the

group. *Endoxylon zonatum* was found in the Carboniferous Limestone series, Dalry, Ayrshire, by the late Dr. John Young of Glasgow. The large pith consists wholly of cellular tissue, surrounded by a number of scattered strands of primary wood. The secondary wood has very narrow, and usually low medullary rays, and is notable for showing well-marked annual rings, characterised by the narrow-celled zones of "autumn-wood." The bark is preserved in this specimen, an unusual feature. The other specimens illustrate two species of the genus, Bilignea, a genus founded by Dr. Kidston, and characterised by the fact that the pith is wholly replaced by a massive central column of short tracheids, presumably for the storage of water. This genus may be described as Eristophyton with the pith replaced by a column of water-storing tracheids. Whether this peculiar structure was derived from a primitively solid wood or from a pre-existing pith cannot yet be decided.—E. L. **Ince**: On a class of partial differential equations. Equations of which $\frac{\partial^2 z}{\partial x^2}+\frac{\partial^2 z}{\partial y^2}+(n+1-x^2-y^2)z=0$ is typical are considered; a set of particular solutions and a solution of a general character are obtained.—Sir Thomas **Muir**: The theory of circulants from 1900 to 1920.

Paris.

Academy of Sciences, June 23.—M. Guillaume Bigourdan in the chair.—G. **Bigourdan**: The determination of time, and the modified use of the method of corresponding heights. A review of the six methods that have been used, with discussion of the relative advantages and disadvantages of each. The method of corresponding heights of known stars has for a long time been considered the most exact: a modification leading to increased precision is proposed.—F. **Widal**, P. **Abrami**, A. **Weill**, and **Laudat**: Hydremia in the course of diabetes under insulin treatment. Variations in the refractive index of the serum. Insulin profoundly affects water metabolism, causing blood dilution, and these changes can be conveniently followed by the refractometer.—Pierre **Weiss** and Mlle. Paule **Collet**: Paramagnetism independent of the temperature.—V. **Grignard** and R. **Stratford**: The catalytic decomposition of hexahydroaromatic and saturated fatty hydrocarbons. Contribution to the study of the cracking of petrol. The decomposition of pure individual hydrocarbons has been studied; anhydrous aluminium chloride was used as catalyst and the temperatures were generally between 120° and 150° C. The gaseous and liquid products of the reaction were identified. The substituted cyclohexanes undergo a double transformation, a cracking increasing with the length of the side chain, and isomerisation leading to polymethyl cyclohexanes. Both fatty hydrocarbons and substituted cyclohexanes give normal butane under the action of aluminium chloride.—Jean **Effront**: The toxicity of copper salts.—M. Giovanni Battista De Toni was elected correspondant for the section of botany in succession to the late M. Warming.—Marcel **Légaut**: The systems of points in a plane.—G. **Maneff**: Gravitation and the principle of action and reaction.—M. de **Fleury**: Concerning the use of light or extra-light alloys for the pistons of internal combustion engines.—P. **Dumanois**: Concerning aviation motors with very high compression. Some consequences resulting from the use of an antiknocking compound, such as lead tetra-ethyl, in petrol used for aviation motors.—V. **Michkovitch** and E. **Mallein**: A prism astrolable with an impersonal micrometer.—Alfred **Lartigue**: The application to thermodynamics of the representation of Fresnel.—P. **Lejay**: The use of lamps with several electrodes in electrometry.—Georges **Chaudron** and Hubert **Forestier**: Study of the decomposition of ferrous oxide. Anomalies of expansion corresponding with its instability. It has been shown in an earlier communication that ferrous oxide is unstable below 570° C. and that it decomposes according to the reaction $4FeO \rightleftharpoons Fe_3O_4 + Fe$. The present paper gives the result of a study of the velocities of these two inverse reactions.—P. **Laffitte**: The spectroscopy of explosions. With a gaseous explosive the spectrum of the explosive wave, and that of the period of combustion, is a continuous spectrum, the only lines observed being those of elements in the walls of the containing tube. For a solid explosive, the spectrum is continuous without lines.—A. **Damiens**: The absorption of carbon monoxide by cuprous sulphate in the presence of sulphuric acid. Application to the production of hydrogen from water gas. With cuprous oxide dissolved in strong sulphuric acid, the absorption of carbon monoxide is complete up to the limit one molecule of carbon monoxide to one molecule of copper sulphate, and no gas is evolved by this solution in a vacuum. The carbon monoxide is removed by dilution and warming.—Edmond **Bayle** and René **Fabre**: Study of the fluorescence of the alkaloids of the isoquinoline and tetrahydroisoquinoline groups, papaverine, narcotine, hydrastine, and their products of oxidation.—E. **Darmois** and A. **Honnelaitre**: The electrometric study of the acidity of mixtures of malic acid and molybdic acid. The results of the measurements confirm those obtained by the polarimeter: the latter method, however, is much more sensitive.—P. **Lasareff**: A possible cause of the anomaly of gravity at Koursk (Central Russia).—E. **Chaput**: Two types of alluvial sheets: monogenic and polygenic terraces.—Emile **Saillard**: Estimation of raffinose in sugars. Proportion of raffinose in molasses.—R. **Courrier**: New researches on folliculine. Contribution to the study of the passage of hormones through the placenta.—D. **Bach**: Variations of the concentration of hydrogen ions in the course of the assimilation of the ammonium salts of strong acids by *Aspergillus repens*.—A. **Fernbach** and N. **Schiller**: The rôle of the reaction of the medium in elective fermentation.—G. **Petit**: The morphogemy of the kidney of the sirenians.—Ph. **Joyet-Lavergne**: The evolution of the cytoplasmic elements in the cycle of *Aggregata Eberthi*.—A. **Donatien** and F. **Lestoquard**: Pernicious anæmia of the sheep and the goat.—B. **Issatchenko**: Sulphuretted hydrogen fermentation in the Black Sea. The reduction of sulphates to sulphuretted hydrogen in the Black Sea appears to be due to an organism identical with one described by Beijerinck and by van Delden under the name of *Microspira æstuarii*. MM. **Ménard** and **Foubert**: The technique of the treatment of medico-surgical affections by ultraviolet light.—H. **Penau** and H. **Simonnet**: Experimental pancreatic diabetes and insulin.

Copenhagen.

Royal Danish Academy of Sciences, February 1.—N. E. **Nørlund**: On the series of interpolation. A determination of the class of functions which may be represented by the usual expansions of the interpolation theory.

February 15.—J. L. W. V. **Jensen**: Results of some earlier mathematical investigations, hitherto unpublished: (1) Asymptotic determination of the roots of the Q-function of Prym.

March 14.—N. **Bjerrum**: On the dissociation constant of methyl alcohol, worked out together with Miss Unmack and L. Zechmeister. Methyl alcohol dissociates reversibly into ions, and the dissociation

constant is determined at different temperatures and ion-concentrations.

March 28.—Harald **Bohr**: Quasi-periodic functions. General determination of the classes of functions which can be resolved into arbitrarily chosen vibrations (harmonic or otherwise). The inquiry forms a generalisation of the theory of the usual Fourier series. With the help of certain generalisations of the notion of periodicity, it is possible to reach a simple and complete characterisation of the class of functions indicated.

April 11.—P. O. **Pedersen**: On electric sparks. (2) An experimental investigation on time-lag in the electric spark and on spark-formation under various conditions. (3) It is shown that the present theory of the electric spark in some essential points is contradictory to experience and particularly to the experimental results described in (1) and (2). The outline of a new spark theory is sketched.

April 25.—L. Kolderup **Rosenvinge**: The marine Algæ of Denmark, (3): Ceramiales. The Danish species of this order, contributions to their morphology and development, their fructification and occurrence in Danish waters.—Niels **Nielson**: An equation of Lagrange studied by Cayley. The memoir gives a generalisation of the equation studied by Cayley (*Journal de Crelle*, vol. 53). The parameter 4 is replaced by any power of any prime number whatever. The memoir gives the necessary and sufficient conditions for the solution of this generalised equation, also formulæ which allow certain equations corresponding to parameter 4 to be solved at once or proved insoluble.

ROME.

Royal Academy of the Lincei, May 4.—C. **Segre**: Curvilinear elements having tangent and osculatory plane in common.—A. **Angeli**: Analogies in behaviour between certain derivatives of benzene and the corresponding derivatives of the aliphatic series.—G. **Armellini**: Observations on the diameter of the sun made at the Royal Rome Observatory on the Campidoglio. The meridian observations taken at this observatory during the past forty years are used as the basis of calculations of the sun's diameter. The results are independent of any personal factor and are subject only to a very small error due to the inclination to the vertical of the micrometer wires of the transit instrument. The mean value of the radius of the sun at the mean distance, increased by radiation, is found to be $R = 16'1{\cdot}40'' \pm 0{\cdot}02''$, which is almost coincident with that usually accepted, namely, $16'1{\cdot}18''$.—G. **Gherardelli**: Oblique algebraic curves with only autodual branches.—A. **Myller**: Concurrent directions on a surface emerging from the points of a curve.—M. **Picone**: Necessary and sufficient conditions for the existence and calculation of a periodic solution for the most general system of ordinary differential equations.—G. **Charrier**: Oxidation of 2-*N*-phenyl-$\alpha\beta$-naphthatriazole by means of alkaline potassium permanganate solution.—G. R. **Levi** and G. **Natta**: Action of aluminium sulphide on certain organic compounds. At high temperatures, the action of aluminium sulphide on benzene results in the formation of various condensed aromatic hydrocarbons. Under similar conditions, phenols or naphthols are transformed into the corresponding oxides, whereas from alcohols of the aliphatic series, mercaptans may be obtained in good yield and free from organic sulphides.—B. **Oddo** and D. **Curti**: Oximic and iminic compound of the phthalein of phenol.—A. **Desio**: Geological constitution of certain islands in the Ægean Sea.—A. **Clementi**: Osmotic pressure in terrestrial invertebrates. Just as is the case with the vertebrates, so also with the invertebrates, the osmotic pressure of the internal fluids of the organism is less with terrestrial than with marine species, the maximum value in the case of one and the same organism being less in the internal fluids than in the solid tissues.—M. **Sella**: Observations on the development and anatomy of the myotome in the Teleostei.

Official Publications Received.

Bulletin of the American Museum of Natural History. Vol. 50, Art. 1: A Revision of Palæomastodon, dividing it into Two Genera, and with Descriptions of Two New Species. By H. Matsumoto. Pp. 58. (New York City.)

South African Association for the Advancement of Science. Twenty-second Annual Meeting, Cape Town, July 7th to 12th, 1924. Official Programme. Pp. 19. (Cape Town: The University.)

Report of the Department of Industries, Madras, for the Year ended 31st March 1923. Pp. iv+86. (Madras: Government Press.)

Proceedings of the Tenth Indian Science Congress. Pp. xvi+289. (Calcutta: Asiatic Society of Bengal.) 7.8 rupees.

Colony of Southern Rhodesia. Report of the Director, Geological Survey, for the Year 1923. Pp. 9. (Salisbury, South Rhodesia.)

Forestry in the Malay Peninsula: a Statement prepared for the British Empire Forestry Conference, Canada, 1923. By G. E. S. Cubitt. Pp. 24. (Kuala Lumpur: Government Printing Office.)

Ministry of Public Works, Egypt: Physical Department. Some Experiments on the Rating of Current Meters. By P. Phillips. (Physical Department Paper No. 14.) Pp. 17+7 plates+17 graphs. (Cairo: Government Publications Office.) 5 P.T.

Forest Bulletin No. 56: A Report on the Tan Values of Indian Myrobalans and Burma *Terminalias*. By J. A. Pilgrim. Pp. 29. 6 annas. Forest Bulletin No. 57: Tan Investigation of the Burma Hill Pine, *Pinus Khasya*, bark and *Pyinkado, Xylia dolabriformis*. By J. A. Pilgrim. Pp. 7. 3 annas. (Delhi: Government Central Press.)

The Indian Forest Records. Vol. 10, Part 9: Tannin Investigation of some Burmese *Dipterocarps*. By J. A. Pilgrim. Pp. iii+23. (Delhi: Government Central Press.) 7 annas.

Union of South Africa. Department of Mines and Industries: Geological Survey. Memoir No. 22: A Subject Index to the Literature on the Geology and Mineral Resources of South Africa. By A. L. Hall. Pp. 384. (Pretoria: Government Printing and Stationery Office.) 10s.

University of Colorado Bulletin. Vol. 24, No. 4, General Series No. 205: Catalogue, 1923–1924; with Announcements for 1924–1925. Pp. 390. (Boulder, Colo.)

Bulletin of the American Museum of Natural History. Vol. 50, Art. 2: Third Contribution to the Snake Creek Fauna. By W. D. Matthew. Pp. 59-210. Vol. 50, Art. 3: The Marine Ornithology of the Cape Verde Islands; with a List of all the Birds of the Archipelago. By Robert Cushman Murphy. Pp. 211-278. Vol. 50, Art. 4: The House Wrens of the Genus Troglodytes. By Frank M. Chapman and Ludlow Griscom. Pp. 279-304. (New York City.)

Sudan Government: Scientific Research Committee. Report of the Committee for the Year 1923. Pp. 13. (Khartoum.) 2 piastres.

Calendar of the University of Adelaide for the Year 1924. Pp. 410+108+13. (Adelaide.) 2s. 6d.

State of Illinois. Department of Registration and Education: Division of the State Natural History Survey. Exchange and Distribution List of available Publications of the Illinois State Natural History Survey and its predecessors the Illinois State Entomologist's Office and the Illinois State Laboratory of Natural History. Pp. 21. (Urbana, Ill.)

Department of Commerce: Bureau of Standards. Circular of the Bureau of Standards, No. 74: Radio Instruments and Measurements. Second edition. Pp. 345. (Washington: Government Printing Office.) 60 cents.

State of Illinois. Department of Registration and Education: Division of the State Natural History Survey. Bulletin, Vol. 15, Art. 1: The Apple Flea-weevil, *Orchestes pallicornis* Say (Order Coleoptera; Family Curculionidæ). By W. P. Flint, S. C. Chandler and Pressley A. Glenn. Pp. iii+37. Bulletin, Vol. 15, Art. 2: Notes on a Collection of Erythroneura and Hymetta (Eupterygidæ) chiefly from Illinois; with Descriptions of New Forms. By W. L. McAtee. Pp. ii+39-44. (Urbana, Ill.)

Smithsonian Institution: United States National Museum. Bulletin 128: List of North American Recent Mammals, 1923. By Gerrit S. Miller, Jr. Pp. xvi+673. (Washington: Government Printing Office.) 85 cents.

Department of the Interior: Bureau of Education. Bulletin, 1923, No. 46: A Study of Distinguished High-School Pupils in Iowa. By Prof. Charles Deich and Elmer E. Jones. Pp. iii+58. 10 cents. Bulletin, 1924, No. 1: Educational Directory, 1924. Pp. iii+191. 20 cents. (Washington: Government Printing Office.)

Department of the Interior: United States Geological Survey. Bulletin 690-B: Gravel Deposits of the Caddo Gap and De Queen Quadrangles, Arkansas. By Hugh D. Miser and A. H. Purdue. Pp. ii+15-27+3 plates. Bulletin 723: Geology and Ore Deposits of the Manhattan District, Nevada. By Henry G. Ferguson. Pp. ix+163+18 plates. 50 cents. Bulletin 746: Geologic Literature on North America, 1785-1918. By John M. Nickles. Part 1: Bibliography. Pp. ii+1167. 1.25 dollars. Bulletin 752: Coal Resources of the Raton Coal Field, Colfax County, New Mexico. By Willis T. Lee. Pp. vi+254+22 plates. 50 cents. Bulletin 754: The Ruby-Kuskokwim Region, Alaska. By J. B. Mertie, Jr., and G. L. Harrington. Pp. vii+129+9 plates. 50 cents. (Washington: Government Printing Office.)

Department of the Interior: United States Geological Survey. Professional Paper 126: Geology of the Coastal Plain of Texas, West of Brazos River. By Alexander Deusser. Pp. xii+139+36 plates. 40 cents. Professional Paper 132-D: The Evolution and Disintegration of Matter. By Frank Wigglesworth Clarke. Pp. ii+51-86. 10 cents. Professional Paper 132-E: An Early Eocene Florule from Central Texas. By Edward Wilber Berry. Pp. ii+87-92. 5 cents. (Washington: Government Printing Office.)

The Institution of Civil Engineers. Engineering Abstracts prepared from the Current Periodical Literature of Engineering and Applied Science, published outside the United Kingdom. Supplement to the Minutes of Proceedings of the Institution. Edited by W. F. Spear. New Series, No. 20, July. Pp. 214. (London: Great George Street, S.W.1.)

NATURE

SATURDAY, AUGUST 2, 1924.

CONTENTS.

Editorial and Publishing Offices:
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.

Editorial communications should be addressed to the Editor.
Advertisements and business letters to the Publishers.

Telephone Number: GERRARD 8830.
Telegraphic Address: PHUSIS, WESTRAND, LONDON.

Museums and the British Empire.

It was fitting that the Museums Association should hold its annual conference this year at Wembley, for the Exhibition is a great museum of Empire, a marvellous example of that education by the visual appeal of concrete objects which is the special characteristic of museum teaching. The inspiration it might afford to the large gathering of museum officials from these islands and from the Dominions overseas was well brought out in the presidential address of Dr. Herbert Bolton, of the Bristol Museum. Trained at the Manchester Museum, for many years director of one of our oldest and best provincial museums, personally acquainted with museum work in the Dominions and the United States, and one who has achieved scientific and academic distinction in the course of his professional labours, Dr. Bolton is eminently fitted to take advantage of the situation, and his constructive criticisms are worthy of respectful scrutiny.

That the museum method is of practical use to practical men is shown clearly enough by the British Empire Exhibition, and so successfully that the Prince of Wales has recently advocated the maintenance of the Exhibition throughout another year. What is still more important is that the impulse given should be guided into those permanent institutions which are intended for the same purpose. It would, indeed, be absurd to organise a vast temporary show of the Empire and to close down the galleries and collections of the Imperial Institute; fortunately we are, as it seems, to be spared that threatened disgrace. But, as Dr. Bolton urged, the Imperial Institute should not stand alone; existing museums all over the country should carry on the work, leading, it may be, to the establishment of independent commercial museums in the large industrial centres. Australia, ever advancing, has shown the way in the Technological Museum of Sydney; Japan, seizing on that which is good in Western civilisation, has trade museums, not only at Osaka, but also scattered throughout the country. The most remarkable example doubtless is the Commercial Museum of Philadelphia, "which has done more to stimulate the trade and commerce of that city than all the other agencies put together." Not that Britain is so far behind: the museums of Sheffield, Halifax, and Hull, for example, have formed collections of metal-work, textiles, and shipping respectively, while for an example of the special museum of industry we need only recall that of the Potteries at Hanley.

Let us not, however, restrict our view to commerce. Public health, to take an activity so admirably illustrated by the tropical diseases exhibit in the Government Building at Wembley, is a subject that can and should be advanced by our ordinary museums. We

cannot have forgotten how several of them rose to the occasion presented by the War, and Dr. Bolton reminded us of the valuable work then done at the Natural History Museum by research and exposition. But all this can be, and indeed is, pursued with profit in times of peace. The American Museum of Natural History in New York has even founded a separate health department.

Space forbids us to follow Dr. Bolton through the many fields in which museums can be of service to the community, from the highest ideals of art to the manurial depths of agriculture, but we must applaud the emphasis with which he once more urges that the prosecution of research is no less incumbent on museums than is the exposition of its results. Here, however, if not before, we are brought up against a formidable obstacle. While our museum officials either have, like Dr. Bolton, been raising themselves to the level of university investigators, or have been increasingly drawn from the higher classes of university graduates, while they have, in short, become skilled men of science no less than highly trained curators, their numbers have not kept pace with the growth of their collections or with the increased demands made on them by the public. Dr. Bolton takes as his example the British Museum (Natural History). As an interested onlooker he asserts that:

"The tasks with which each man has to deal are herculean, and can never be mastered by any one man. Every scientific man of note in the whole world interested in the sciences represented there visits it for study and inquiry, whilst general inquiries are legion. Collections pour in; the labours of Sisyphus were mild in comparison with those of the staff of this museum, for his labours never increased, whilst theirs are continuously mounting up. But this does not touch the question of research. These men do carry out research, but only by making the hours of life the hours of labour. I do not hesitate to say that in the interests of the nation and of the Empire the national museums call for a drastic reorganisation, in order that their hidden treasures may become available for an Empire's betterment and a people's welfare."

It is, indeed, deplorable that this can be said, and said with truth, of the central museum of the Empire, a museum that renders willing service to the whole world. Not all of Dr. Bolton's suggestions will be accepted without qualification, but on this at least we shall be agreed: that one of the best ways of helping the museums of Great Britain and of the Dominions would be an expansion of the staff of the Natural History Museum. If Dr. Bolton is, as we think, right in his belief that museums can do much to knit more closely the brotherhood of the British Empire, then there could be no more secure investment for such funds as may accrue from "The Great Advertisement" at Wembley.

Electrothermic Processes of Steel Manufacture.

The Manufacture of Electric Steel. By Frank T. Sisco. Pp. x + 304. (London: McGraw-Hill Publishing Co., Ltd., 1924.) 15*s*.

UP to the present time several books have been written which deal with electric steel-making furnaces from the point of view of their electric, mechanical, and thermal efficiency. Not one of them, however, describes with any completeness the operation of the furnace and the making of a heat of steel. It has been evident for some time that this was greatly needed, for although the men directly connected with the manufacture of special steels are thoroughly conversant with the electric process and its advantages and disadvantages, those in the steel industry outside of this field have had very little opportunity of becoming familiar with it. In the present volume the author has endeavoured, with much success, to fill this need by discussing thoroughly the manufacture of electric steel, starting with the raw materials and ending with the teeming of the ingots. After the heat is poured and the ingots stripped, the furnaceman's duties are ended. If he has delivered a first-class ingot to the rolling mill or the forge, this represents his part of the effort necessary to the manufacture of a satisfactory product.

The electrothermic process of steel manufacture is the infant—a lusty one—of the iron and steel industry. Little more than twenty years ago the manufacture of steel by this process was still in the embryonic stage. To-day about 1200 electric furnaces are operating in America and Europe. The advance during the past ten years has been nothing short of astonishing, production having increased from 52,000 tons in 1910 to 502,000 tons in 1920. The recognised ability of this process to produce high quality alloy and tool steel ingots, and the superiority of the process over others in the manufacture of castings, is responsible for this advance. In view of the existing literature, the author has devoted comparatively little space to the description of the furnaces themselves. Even in the case of the Héroult furnace, which is the largest single producer of electric steel, manufacture and construction of the electrical details are only lightly touched on. In the United States of America, Héroult furnaces up to 30 tons capacity are in regular use, and are of a size comparable with open-hearth furnaces.

The electric furnace is unique in ferro-metallurgical processes in that it will produce a high-grade material in tonnage lots. The author claims that the same quantity of steel, say 30-50 tons, delivered by the open-hearth can be made in an electric furnace of a quality

equal to the best product of the crucible pot. One of the great advantages of the electric process is flexibility and control. It can be operated with cold charges or hot metal. It can also be used for making pig-iron synthetically or for refining molten cupola iron. The temperature can be controlled within a few degrees. Deoxidation and reduction can be carried to any desired point and sulphur and phosphorus eliminated down to traces. Compared with steel made by the open-hearth or Bessemer process, electric steel has greater density and is much freer from slag and occluded or absorbed gases. It is stronger, tougher, and more ductile.

The outstanding disadvantage of the process is its cost. The author anticipates that this is destined to become a less serious handicap as power resources become more completely developed and economy of furnace operation is more thoroughly understood and practised. Another disadvantage is that furnaces are often operated by men unversed in deoxidation and thus a steel is produced which is not so good as it should be. A more thorough training is required for the furnace operators. Moreover, electric furnaces are frequently installed as adjuncts to open-hearth furnaces by companies interested primarily in the production of large tonnages. The electric furnace occupies a field of its own and may, with the greatest economy and best results, be operated in conjunction with another melting operation, but should never be used as a subsidiary to it. To quote the author: "Washing hot metal in an electric furnace and calling it electric steel has done much to give it a bad name."

The chapter on the chemistry of the basic electric process is one of the best in the whole book. The author discusses fully and fairly both the oxidation and deoxidation periods. After deoxidation is complete and the alloy additions have been made, the hot metal lies in the furnace covered by a very basic slag containing up to 65 per cent. of calcium as oxide with 13 per cent. of calcium carbide. Through the agency of these, iron oxides and manganese oxide are almost wholly eliminated from slag and bath, the addition of ferro-manganese and ferro-silicon completing the elimination. The fusible silicates of iron and manganese formed in small amounts have had time to separate from the steel. Carbon monoxide gas has been eliminated by silicon, leaving in its place silica, of which a very small amount remains dispersed in the metal. Sulphur is present in the form of manganese sulphide to the extent of one part in five thousand. It is practically impossible to get it out of the steel. Gases should be almost entirely absent. Except, therefore, for small amounts of manganese sulphide and still smaller amounts of silica, the steel should be free from non-metallic inclusions. In these respects it is markedly superior to even the best open-hearth steel.

The author devotes some attention to the Austrian practice of melting chrome-nickel steel for aeroplane shapes. The charge is melted and refined with the idea of producing a so-called fibrous structure which, according to Kothny, is necessary to meet the Austrian army specifications. He challenges the practice *toto caelo*, and gives very good reasons for concluding that the fibrous condition formerly considered so beneficial to steel is in reality harmful.

Mr. Sisco, who is an American metallurgist, has written a valuable book, and by his own work in this subject is making an important contribution to placing the manufacture of electrothermic steel on a scientific basis. His style is clear and his language apt, and he emphasises his main points so that he may be thoroughly understood by men who operate furnaces. The book will also be of service to college students and young metallurgists for the clear picture it gives of the essentials of the best accepted practice in both basic and acid processes.

H. C. H. C.

Tycho Brahe's Observations.

Tychonis Brahe Dani opera omnia. Edidit I. L. E. Dreyer. Tomus X. Pp. xxvii+434. (Hauniæ: In Libraria Gyldendaliana, 1923.) n.p.

THE Carlsberg Foundation and the president of the Royal Astronomical Society are to be thanked for presenting us with a most interesting, if not very readable book. The tenth volume of the works of Tycho Brahe is the first volume of his observations, and contains his observations down to the year 1585. The editor's prolegomena tell the history of the manuscripts in which these observations were recorded, of successive projects for their publication, and of the imperfect publications which have appeared. The obstacles to publication were not, it would appear, entirely material. We are quite accustomed to observations being made by one astronomer and theoretical deductions by another, and Ludwig Kepler's contention, thirty-six years after Tycho Brahe's death, that his observations should be reserved for the emperor alone and those to whom, as a special favour, he should grant the use of them, is what we should nowadays expect to find only in the case of discoveries of commercial value, not of astronomical observations. It will be noticed that the sole right to draw deductions seems to pass with the MS. observations after the observer's death. Happily, Kepler had been the owner, and these observations provided him with the material for his laws of planetary motion and his Rudolphine Tables.

There are two great MS. collections of Tycho's observations, both made under his own direction and both containing notes in his own hand. One, now preserved at Copenhagen, contains the daily or nightly record; the other, now at Vienna, arranges the observations of each year according to the bodies observed. Neither is quite complete. Dr. Dreyer has, where possible, followed the text of the Copenhagen and the arrangement of the Vienna MSS.

The one previous edition of any degree of fulness was that of Albert Curtz, which appeared in 1657–66, but it is defaced by many grave defects. It was based on what is now the Vienna MS. The numerous subsequent projects were based mainly on the Copenhagen MSS. or on Curtz corrected from those MSS. After an abortive project of the Royal Society in 1707, proposals for a complete edition practically died away, the one exception being Hvass's project to include the observations in a complete edition of Tycho's works in 1778. This was inevitable. The observations had for the most part come to belong to the history of astronomy. They had lost their living value. Pingré used for his "Cométographie" in 1783 a copy which Bartholin had prepared for printing and never printed, and the observations of comets were published in full by Friis in 1867. These observations at least could not be superseded.

The present most scholarly edition is probably to be classed as a work of piety rather than as a contribution to the progress of science. But without investigation it is impossible to say how far back observations are useful. A sign of the editor's extreme pains is that where there has appeared to be an error in the record of observations, he has attempted to discover its cause by means of computations.

The student of Tycho will find mixed with the observations mathematical constructions and discussions of the quantities dependent on the observations. These increase the interest of the book to any one who studies the history of astronomy. It would be useful to have in some later volume a glossary of star-names.

J. K. F.

A New Natural History.

The Animal and its Environment: a Text-Book of the Natural History of Animals. By Dr. L. A. Borradaile. Pp. vii + 399 + 4 plates. (London: Henry Frowde and Hodder and Stoughton, 1923.) 18*s.* net.

EVERY zoologist will grant that animals should be studied in relation to their surroundings. Physiologically, as Huxley said, they are whirlpools in the river; morphologically, they are, in part at least, bundles of adaptations, definitely related to environmental conditions. Embryologically considered, they develop in a particular "nurture," and they may develop differently when the circumstances are altered. Etiologically, they must be considered in relation to environmental stimuli and environmental sifting; isolation is often an environmental affair; the pulse of evolution changes its throbs with the climate. Then there is the behaviour of the creature, so largely concerned with thrust and parry between organism and environment. In certain cases we are most impressed with the grip of the environment on the organism; in other cases, what strikes us is the dominance of the organism over its environment. As Prof. Patrick Geddes has neatly put it, life is a balancing between Organism→function→environment and Environment→function→organism: $\frac{\text{Ofe}}{\text{Efo}}$. All zoologists recognise theoretically the inseparability of the animal and its surroundings, but the truism has not always been evident in their books and lectures. Therefore one gives a hearty welcome to Dr. Borradaile's new natural history which definitely considers animals in relation to their environment. It may be regarded as a continuation of Semper's unsurpassed "Natural Conditions of Existence as they affect Animal Life" (1881).

The book begins by envisaging animals in their natural setting. The organism runs the gauntlet of physical influences and animate influences. There are relations between animals and plants, between animals and their kindred, between animals and other species, and between the sexes. It does not seem easy, if desirable, to separate the animate from the non-living environment; yet one feels that, just as with mankind, there is a difference between mutual relations among living creatures and the relations between living creatures and their *milieu*, or, let us say, climate. Anyhow, what we should call the more distinctive environmental note is sounded emphatically in the subsequent chapters dealing with the faunas of the sea, of fresh waters, and of the land. Then follow chapters on the evolution of faunas, migration, and internal parasites. The concluding chapter deals with the influence of surroundings upon the animal organism, a consideration of which lands the author in an unnecessary scepticism as to the organism's power of "real initiative."

Dr. Borradaile gives many familiar facts a new setting, but he has also a wealth of fresh material. All is presented clearly and educatively, with a generous supply of interesting figures. There are four very beautiful coloured plates. The book is to be strongly recommended in itself and as a supplement to other modes of treatment. There are very few words in

it that could be dispensed with, and we do not know that the author could have used his space to better effect, but we venture to suggest for a new edition that more space should be given to the inter-relations between plants and animals and to the seasonal changes of environment. Dr. Borradaile has deliberately refrained from discussing theories of evolution (as to the steps and factors in the historic process), but we cannot agree with his view that "these subjects are but remotely connected with that of the relation between the individual and its surroundings, which is best studied for its own sake." This seems like a reaction to biological statics, quite inconsistent with the temper of a very dynamic book. The existing relations between organisms and their environments must, of course, be described and analysed, but sooner or later they must also be studied as historically determined results. And in this inquiry the changes of environment from age to age must be appreciated. Prof. Huntington, thinking chiefly of the climatic factor in man's history, writes on "The Pulse of Asia"; the zoologist cannot afford to lose hold of this clue. There is a pulse in evolution.

In regard to the chapter on parasitism, where the author shrewdly recognises the heterogeneity of the phenomena, we think that he misses an opportunity of striking out from an outworn conventional concept. "Parasitism" is a too convenient label and it has been badly strained; there are (see Borradaile) at the very least half-a-dozen different kinds of parasitism. That seems to us to indicate the one-sidedness of the environmental grouping in general. Just as we have plankton and nekton in the open sea, illustrating one of the great organic dichotomies, so there is a sharp contrast between a tapeworm and a trypanosome. But we are not blaming Dr. Borradaile for the intricacy of Nature; we are rather, in our hyper-criticism, paying our best compliment to a notable new departure in natural histories. We hope it will have the great success it deserves.

Chemistry of Colloids.

Colloid Chemistry: Wisconsin Lectures. By The. Svedberg. (American Chemical Society Monograph Series.) Pp. 265. (New York: The Chemical Catalog Co., Inc., 1924.) 3 dollars.

COLLOIDAL solutions of the suspensoid type, although not always of immediate technical importance, have many advantages as material for the investigation of the quantitative factors in disperse systems. Sols can be prepared with particles of known and regular size, and, provided conditions of formation are carefully regulated, the systems can often be reproduced within quite narrow limits. The stability of these colloidal solutions does not depend to any great extent on the hydration of the particles, and is therefore not affected by the previous treatment of the solution to the same degree as in sols of the emulsoid type. Indeed, the suspensoids approximate most closely to the purely physical conception of a colloidal system as particles of small size dispersed in a pure continuous medium.

The numerous and fundamental researches of Prof. The. Svedberg have mostly been concerned with colloids of this type, and in the present volume, which embodies a course of lectures delivered at the University of Wisconsin in 1923, this work is summarised with copious references to the related discoveries of other investigators. The title "Colloid Chemistry" is thus misleading unless read with some emphasis on the subtitle. For example, only fifteen pages of the whole book are devoted to gels, and emulsions are scarcely mentioned at all. The author apologises for his bias in the preface, but it should have been indicated in the title of the book.

When, however, the restricted scope of the volume is realised, its value becomes greater than it would be if it were a more general treatise. The author is naturally impatient and distrustful of the merely qualitative or at best empirical experiments which are common in colloid chemistry, and so tends to confine his summary to accurate work on well-defined systems. The methods of formation are first considered and include an interesting account of the work of the author on the electrical dispersion process first worked out by Bredig. In this section the usual methods of purifying colloidal solutions are discussed, including several types of apparatus for electro-dialysis developed in the last few years. In the second part the colloidal particle is considered as a molecular kinetic unit, and the determination of Avogadro's number from the rate of sedimentation of these particles, giving values in remarkable agreement with those obtained by other methods, is described in detail. Among the methods by which the size of colloidal particles can be found is mentioned the calculation from the width of the lines in the X-ray diagram, which should prove a serviceable approach to this difficult determination in the future.

In the third section, under the title of "The Colloid Particle as a Micell," such subjects as adsorption, electrophoresis, coagulation and gel formation are introduced. This portion of the book is worked out in much less detail than the first two sections, and the author wisely refrains from dealing with the tangled mass of results which makes up our knowledge of the coagulation of colloids by electrolytes, and confines his remarks to fairly general statements. Peptisation,

again, with the mass of empirical information which represents practically all we know of that phenomenon, is dismissed in a single paragraph; and protection, of such great importance in technical work, is treated in an equally cursory manner.

It is, perhaps, unreasonable to expect a new branch of science to develop evenly in all directions, but in reading this book one is struck by the extent to which investigators in colloid chemistry have been occupied with systems in which water is the continuous medium. The extreme sensitiveness of aqueous suspensoids to slight traces of impurities, and the variation in properties of emulsoids with minute changes in the concentration of hydrogen and other ions, make the most heroic precautions necessary to avoid complete vitiation of results. The detailed study of non-aqueous and in particular of non-ionising liquids as the dispersion medium is now imperative, if only to clear up some of the results obtained with water. Prof. Svedberg's book indicates what can be done with fairly simple systems with specially designed apparatus, but we can look forward to results even more astonishing and important in the near future.

The author must be congratulated on writing so clearly in a language which is not his native tongue, and also on amplifying his narrative with more than a hundred excellent illustrations, most of which are original. The formal diagrams of the apparatus are frequently supplemented by photographs taken in the laboratory. It is a pity that the printing of the mathematical expressions is so amateurish, so that at times, as for example on pp. 94 and 151, the result is more decorative than intelligible. The value of the book to the scientific worker is increased by the selection of key references which is so constant a feature of the author's publications. For those without the time or opportunity to read the papers in the original, the volume provides an excellent summary of important work in the field with which it deals.

P. C. L. THORNE.

Our Bookshelf.

The Peaks, Lochs, and Coasts of the Western Highlands; Penned and Pictured with One Hundred Photographs. By Arthur Gardner. Pp. xi + 169 + 100 plates. (London: H. F. and G. Witherby, 1924.) 15*s.* net.

THE value of this work rests on its collection of photographs, most of which are excellent in quality and well illustrate the structure and character of the Scottish Highlands. The most beautiful are those of the western coast to the south of Skye. Those of the mountains in the interior have a certain monotony which is, however, instructive, as it represents the frequent recurrence of the same physiographic types. The text consists of an account of the author's journeys with hints to other photographers. The information is too indefinite to serve as a guide, and includes little as to the history, natural history, or geology of the country. The author expresses interested ignorance as to the nature of some of the rocks illustrated by his photographs, which might have been easily removed by reference to a geological map. He deplores the extent of the country devoted to deer forests, both on economic grounds and because they render much of it inaccessible during the usual holiday season. He laments the closing of inns which has rendered impracticable to most pedestrians some of the most beautiful routes across the country. The author also regrets the inconsiderateness of the landlords in planting the clumsy Austrian instead of the picturesque Scottish pine, from which it may be inferred that the author is a better photographer than forester. The book, as a useful collection of geographical photographs, will be of most interest to those who wish for a picturesque souvenir of the western Highlands.

The Hampshire Gate. By H. G. Dent. Pp. 179 + 14 plates. (London: Ernest Benn, Ltd., 1924.) 8*s.* 6*d.* net.

OF the southern inlets into England, physical circumstances have made the Solent and Spithead, with the valleys that give access to them, one of the most important. This may be termed the Hampshire Gate. Its value was very marked when Winchester enjoyed the full significance of its site as a focus of routes in southern England. The importance of Southampton dwindled with the Portuguese discovery of the Cape route to India, which involved the diversion of much Mediterranean trade, but eventually it revived with expansion of Empire and the growth of American trade. Miss Dent's book treats of the Itchen basin, and is mainly a study in historical geography. The relation between physical conditions and trade routes is clearly shown. A considerable part of the book is naturally devoted to the port of Southampton: Winchester gets relatively little notice. The study, so far as it goes, is a useful piece of work, and is a good example of regional treatment in geography. The maps are small but clear.

History of the Great War, based on Official Documents. Medical Services: General History. Vol. 3: *Medical Services during the Operations on the Western Front in 1916, 1917, and 1918; in Italy; and in Egypt and Palestine.* By Maj.-Gen. Sir W. G. Macpherson. Pp. viii + 556. (London: H.M. Stationery Office, 1924.) 21*s.* net.

THIS volume deals with the medical arrangements of the War in France, Belgium, Italy, Sinai Peninsula, Egypt, Palestine, and the Senussi Expedition. Particularly detailed were the arrangements in the Somme battles of 1916, the advance to the Hindenburg Line (1917), Vimy Ridge (1917), Messines (1917), Ypres (1917), Hill "70" (1917), the German offensive of 1918, the Lys region, and the final advance to victory, ending with the occupation of Mons on November 11, 1918. Apologies are offered that the volume could not be made more attractive to general readers. It is hoped that omissions may be made good by a study of the maps and charts which are in profusion.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Pressure in the Reversing Layer of Stars and Origin of Continuous Radiation from the Sun.

THERE seems to be at present a wide divergence of views regarding the magnitude of pressure in the "reversing layers" of stars. While earlier investigators assigned to it a pressure of one to ten atmospheres, on the basis of pressure shift of lines to the red, these experiments do not appear to carry much weight at present. Fowler and Milne (Monthly Notices R.A.S., vol. 83, p. 415, 1923) actually assign to it a pressure of the order of 10^{-3} to 10^{-4} atmospheres.

The following speculations will show that probably an accurate method of determining the pressure may be developed from the limit of series absorption of elements in the Fraunhofer spectrum. To introduce the subject, let us start with the well-known fact that in the Fraunhofer spectrum of the sun the Balmer series of H absorption lines abruptly terminate at H_ζ, while in the flash spectrum no less than 35 Balmer lines are found. Here the ionisation theory does not help us, for all Balmer lines require the same H atom (in the diquantic state) for absorption. We are therefore confronted with the fact that as continuous radiation pours through the H(2) atoms, pulses which lift the electron up to the 8th quantum orbit are freely absorbed, but pulses which would lift the electron to the higher orbits somehow fail to be absorbed in spite of the presence of suitable absorption centres. Something prevents the development of the H-orbits beyond certain limits.

The next step is naturally to identify this agency with the congestion in the reversing layer due to high concentration of particles. In order that the nth-orbit may be developed, the electron should be capable of passing to an average distance of $0{\cdot}532 \times 10^{-8} \times n^2$ cm. from the nucleus. But if within this distance it comes under the influence of a second nucleus, or another electron, there can be no free development of the orbit: the electron will become either free, or attach itself to another nucleus. Hence for rays shorter than H_ζ, the H(2) atoms in the particular layers treated will lose their power of picking up the pulses corresponding to the Balmer series, but will exercise a sort of general, though much enfeebled, absorption on all radiation beyond H_ζ, somewhat after the manner of X-ray absorption. This part will be freely emitted only by higher layers, where the pressure has fallen to sufficiently low values; in other words, if the solar atmosphere were composed of H(2) atoms only, part of the continuous spectrum beyond H_ζ would originate from somewhat higher levels than the redder part of the spectrum.

The idea helps us to get a clearer view of the origin of continuous radiation from the sun. For what has been said of H(2), absorption is a general phenomenon, and can be extended to all other elements. In fact a scrutiny of the Fraunhofer spectrum shows that quantum orbits higher than the 5th or the 6th (total quantum number) are rarely developed. The following examples illustrate the point: [1]

[1] See Russell, *Astrophysical Journal*, vol. 55, p. 130. According to some authors, H_ϵ is the last absorption-line of the Balmer series. It is always difficult to trace the last line, as it is usually very faint.

Element.	Last Series-line in the Fraunhofer Spectrum.	Corresponding Wave Number of final Orbit.
H	$H_\epsilon,\ \nu = N\left\{\frac{1}{2^2} - \frac{1}{7^2}\right\}$	2238
	$H_\zeta,\ \nu = N\left\{\frac{1}{2^2} - \frac{1}{8^2}\right\}$	1714
Na	$2p_1 - 6d,\ \lambda = 4668{\cdot}60$	3062
	$2p_1 - 6s,\ \lambda = 4751{\cdot}89$	3437
Mg	$2P - 6D,\ \lambda = 4351{\cdot}94$	3649
Ca	$2P - 4D,\ \lambda = 5188{\cdot}85$	6385
	$2P - 5S,\ \lambda = 4847{\cdot}29$	5028

For every one of these elements conclusions similar to that in the case of hydrogen hold. Thus, since the higher members of the series lines are in the ultra-violet, there will be cumulative continuous absorption on the short wave-length side. Hence, as a rule long waves will come from deeper layers, short waves from higher layers. How satisfactorily this view accounts for the distribution of energy in the solar spectrum will be evident from the following passage: "Both the observed curves of distribution of energy in the solar spectrum (by Wilsing and Abbot) agree in having a much more pronounced peak than the black body curve, in being depressed below the latter in the violet (*the drop of intensity on the violet side of the maximum being very sudden*), and in coinciding with the black body in the extreme infra-red" (Milne, Phil. Trans., A, vol. 223, p. 218).

Thus for different rays we have different photospheres, but the distances separating the extreme photospheres probably do not differ by so much as 100 km. The photospheres and the reversing layers thus get very much mixed up. Owing to the rapid density gradient of luminous matter (except probably in the case of such atoms as are maintained by selective radiation pressure) the luminosity of the concentric layers round the sun decreases very rapidly. For example, it is well known that if, when obtaining the Fraunhofer spectrum, exposures of longer duration than 1/100 sec. are given, there is no contrast, all dark lines becoming bright. But to obtain the spectrum of layers about 100 km. from the disc during total solar eclipses, exposures of 4 to 10 sec. are required This shows that the so-called dark lines of the Fraunhofer spectrum are intrinsically 100-1000 times more luminous than the bright lines of the flash. Hence when we expose for the Fraunhofer spectrum, the time of exposure is too short for the chromosphere, which does not, therefore, contribute anything to the resulting photograph. In other words, Fraunhofer absorption is caused by layers close to the disc, the higher chromosphere contributing nothing to the process.

These ideas may be extended to stars. According to a rough calculation, if n is the quantum number corresponding to the last absorption line of the Balmer series in a star, $n \propto \left(\frac{T}{P}\right)^{\frac{1}{6}}$. I have been able to collect the data for three A-type stars, α Cygni (ab. mag. $-4{\cdot}5$), α Lyræ (ab. mag. $+0{\cdot}6$), α Canis Majoris (ab. mag. $+0{\cdot}9$). In α Cygni, 24 Balmer lines are developed, in Vega 17 (up to H_ρ), and in Sirius 13. Now α Cygni is a typical giant star, Sirius is a typical dwarf, and Vega lies between them. It is generally admitted that the pressure in the reversing layer of giants is much lower than in dwarfs, and hence the great development of Balmer lines in α Cygnus can be easily understood. Sirius also shows more Balmer lines than the sun, and this is to be ascribed to the joint action of higher temperature and lower pressure in its atmosphere.

For an exact estimation of the pressure from such

data we must wait for further theoretical and experimental work. Much of the idea contained in this communication is to be found in papers by Fowler (*Phil. Mag.*, vol. 45, p. 20), Urey (*Astro. Journ.*, Jan. 1924), Wright (NATURE, vol. 109), Becker (*Zs. f. Physik*, vol. 18, p. 335).

MEGH NAD SAHA.

The Indian Institute of Science.

IN the first column of his article on chemical research in India, in NATURE of June 28, Prof. Thorpe makes reference to the past history of the Indian Institute of Science. I held the office of director for the first half of the period since it was created; and I am glad to have an opportunity of relating the facts with regard to the Institute, now that it is "under the new regime."

In the first place, the term "original purpose" requires some explanation. The proposal to establish a "university of research for India," by the late Mr. J. N. Tata, goes back to the opening of Lord Curzon's viceroyalty, when the matter was first brought to the notice of Government. After much discussion between Mr. Tata and the Government of India, matters took a practical turn when, in the cold weather of the year 1899–1900, Sir William Ramsay went out to India, on the invitation and at the expense of Mr. Tata, to advise on a scheme. Sir William advised in favour of establishing an institution with nuclear departments of chemistry, engineering, and applied bacteriology, but suggested that the main work of the organisation should be to develop industries directly, and that projects should be taken up, developed until they arrived at a paying stage, and then handed over to commercial concerns. The *Government of India rejected this suggestion* as altogether unsound, and I entirely agree with their conclusions.

Professor (now Sir Orme) Masson and Col. Clibborn, principal of Rurki Engineering College, were then asked to report upon Mr. Tata's scheme, and to make recommendations as to carrying it out. They drew up an eminently practical report, recommending the establishment of nuclear departments, a library, etc., much on the lines of Sir William Ramsay's report, but pointing out that the function of the Institute should be restricted to the provision for advanced study and research. The only section of the report with which I am in disagreement is the building proposals, which, as Col. Clibborn afterwards told me, were drawn up rapidly, and were not checked. The report was accepted by the Government of India and by Mr. Tata.

In August 1906 I was offered the appointment of director, being informed by letter by the Secretary of State for India that "in accordance with the will of the late Mr. J. N. Tata" it was proposed to found an institution for advanced study and research, particularly in applied science; and, on accepting the appointment, I was given copies of printed minutes of the Government of India, setting forth the whole story of the Institute, and confirming the idea that the report of Masson and Clibborn had been definitely accepted and must be considered the basis of the organisation which I had to develop.

I did not know until I arrived in India a few months later that Mr. Tata's heirs held a view of the matter different from that which had been communicated to the home Government. They held, in spite of the opinion of the Advocate-General, Bombay, that they were not bound by the will to carry out the scheme agreed upon by Mr. Tata and the Government of India, and they had informed the Government of India that they were only prepared to proceed with a scheme which left in their hands a measure of control far beyond that claimed by Mr. J. N. Tata at any time. In a note on their proposals, Lord Curzon had pointed out that they wished to establish a private institution financed out of the public funds.

Though working compromises were arrived at from time to time, it was not until 1910 that the matter was settled, and then settled on unsatisfactory lines; for to the constitution, as finally adopted, Lord Curzon's criticism might well apply. Further, all agreements prior to Mr. Tata's death were cancelled, and the representatives of Mr. Tata's heirs declared their intention to use every effort to divert part of the funds of the Institute, and the whole of the accumulated balances, which alone were available for properly equipping laboratories, to the establishment of departments dealing with "social and economic studies." Actual and definite proposals for the creation of departments of social and political history, and of certain medical studies, were put forward, and I have masses of documents dealing with these matters. Thanks to the support which I received from the then Resident in Mysore, and to the then Dewan of Mysore, I succeeded in resisting these proposals; but this gave rise to resentment, and before the end of 1909 I well knew that I should have my work cut out to hold on to my post for the eight years of active service in India for which I was appointed.

On the basis of compromise we had begun building operations in May 1908, and a provisional committee was appointed on which the Tata family was represented. The committee did not, however, support the idea of establishing departments of social studies, and was wrecked before the end of the year. Since, however, small contracts which the committee had entered into were still running, Government requested me to carry on. In the autumn of 1909 a provisional council came into existence. I laid before this body proposals based upon the Masson and Clibborn scheme, which had been agreed to in Mr. J. N. Tata's lifetime. An attempt was made to modify it with the view of including social studies, but the majority was against the proposal. The provisional council then entered into contracts for building, etc., amounting to more than 100,000*l.*, and all appeared to go well. However, the political element were not to be beaten. They found a flaw in the constitution of the council, and in May 1910 I was informed by Government that I must spend no more money until certain legal formalities had been completed.

I believe that I should have been well advised if I had cancelled all contracts, dismissed my office staff, etc., and shut down. Such a course would have been officially correct, but contrary, at least, to civilian tradition in India. It was clear that Government dare not help me. The Bank of Madras did, however, come to the rescue, and I was prepared to risk accepting loans on my own account. I carried on for five months; but I knew that the resolution of thanks passed by the reappointed council was not an unanimous resolution of good-will.

By July 1911 the laboratories, etc., were sufficiently advanced to allow of students being admitted, and the Institute actually opened. For a moment the future looked promising, but not for long, for difficulties arose in which the later failures, now to be corrected by "the new regime," found their origin. In their report, to which I have already referred, Masson and Clibborn pointed out that trouble would undoubtedly result if members of local educational and scientific services were elected to the governing body, as interests were certain to come into conflict. Were the Institute to develop on the lines they (Masson and Clibborn) laid down, and provide facilities for study

and research in pure and applied science, it must necessarily come into conflict with the interests of the University of Madras. On the other hand, the departments of industries of Madras and Mysore might find in its staff and laboratories the means of developing their industrial projects. Actually, before I left for home on leave in April 1912, I found that the political opposition had added to itself a service opposition, opposed to carrying out the policy of the Masson and Clibborn report, and supporting the idea of developing the Institute on industrial lines. The position was fairly hopeless, and before leaving for home I laid the whole matter before the Education Department.

During my absence from India an unexpected development took place. In the month of September I received a communication embodying what was said to be a resolution of the council, asking for an explanation on certain matters connected with the building operations, but couched in such language that I could only return to India by the next mail, and proceed directly to Simla, where I asked that a full inquiry into my administration of the Institute should be held with as little delay as possible. I was received most sympathetically, and I was informed that notes on the matter were in my favour, as it was obvious to the authorities that an attack on me had been organised by my staff. I doubted it, but returned to Bangalore to find out. I then learned the following facts. The resolution had been compiled by the official members of the council. It had been read through, or had been said to have been read through, at a council meeting, and passed; but a legal member of the council, on receiving a copy of it, stated in writing that he did not recognise it, and that it prejudged every issue that it raised. I further learned that the officials would oppose an inquiry; and later, when the Viceroy, as our Patron, ordered that an inquiry should be held, and that in the meantime I should return no explanation in answer to the resolution, they flouted his authority, demanding an explanation of me, and when I refused to comply, they addressed a communication to the Education Department recommending that I should be removed from my office without any inquiry being held.

The inquiry was held in May and June of the following year (1913). It was a lengthy business. Every one who had ever been connected with the Institute was asked to come to Bangalore, and to give evidence, but not on oath. I was not asked to be present, and I heard none of the evidence, and yet the terms of reference were "to inquire into the conduct of the director." Towards the end of June I was invited to meet the committee, and to tell the story of the Institute down to the year 1911, but not later. Before the committee broke up I was sent for, and told that it proposed to give me the substance of its report to the Viceroy. What this amounted to was this,—that on two occasions I had failed to circulate papers to the Council, and that I should cultivate better relations with the political element. The matter about the papers had come out in evidence, but I pointed out that the records would show that it was untrue. The second item involved acceptance of the scheme for political studies, which would have brought me into direct conflict with Government. I had been warned to this effect the day I landed in India.

It did not need the assurance of the Indian official who acted as secretary to the committee—I can mention the matter at this distance of time—to make it perfectly clear to me that the attack which the official members of the council had led against me had failed completely; but I knew perfectly well that as a non-official I could not win in this conflict. That the Education Department was in a dilemma was obvious, and contrary to the hopes of my official opponents they made no move until, in the month of September, they wrote me about a further money grant for the completion of certain buildings. It was clear that they wished the matter to be dropped; but a fresh outburst on the part of the official members of the council, who complained that the result of the inquiry had not been issued, resulted in a telegraphic summons to me to go to Simla. When I arrived there I was informed verbally that the situation could only be solved by my resignation, and it was suggested that I should retire on my pension at the end of the following March. The prospect of release was inviting; but on my return to Bangalore a document came into my hands, practically by accident, which put an entirely new complexion on the matter. It was a copy of a printed minute of Government, dealing with the inquiry, and containing all that Government dared say about it, and a great deal more than it dared publish. With reference to myself, it was the finest testimonial I ever received, and if I ever destroy the rest of the vast accumulation of papers relating to this business, I shall keep it as such. However, it showed that, following my resignation, it was proposed to dispense with the services of two members of my staff, who were not, knowingly, the subjects of the inquiry, and a third was to be removed to Madras to avoid competition between his department and a somewhat similar but inferior department in a Madras institution. I at once informed Government that I would not resign upon any terms.

However, my position was an intolerable one, and it was clear that if I stayed on I should have to carry out a policy which I believed to be wrong. Even the stimulus of fighting against it would be lacking. I therefore intimated my willingness to resign, provided that my colleagues were satisfied. Two years' furlough, followed by pension, were actually due to me, and I only asked that the circumstances of my resignation should be made clear in a *communiqué*. This was agreed to, but the *communiqué* was never issued. The late Prof. Rudolf, professor of applied chemistry, agreed to accept six thousand pounds by way of compensation, and he was appointed honorary technical adviser to the Institute, and the other proposed removals were cancelled. Prof. Rudolf left India in March (1914), but I did not get away till the end of June, exactly two years after the passing of the resolution which gave rise to the trouble.

Within a few months an official ex-member of the council was appointed to the vacant post of director. The new day dawned, but the afternoon seems to have clouded up rather badly.

The "new regime" will have found buildings, equipment, and organisation much as I left them at the end of eight somewhat strenuous years, and for which I had to beg most of the money. It will have found a policy against which I fought, losing the battle and also my appointment at the same time. Had I been contented to adopt a policy of *laissez-faire* I should have had an easier time. I might even have earned the commendation of the powers, at the expense of my own self-respect. It now remains for the "new regime" to sweep away the rubbish and carry on from where I left off. If this is done I shall have nothing to regret. MORRIS W. TRAVERS.

23 Stafford Terrace, Campden Hill, W.,
June 28.

DR. M. W. TRAVERS knows better than any one else the inner history of the events he describes. The report of my committee dealt with conditions as we found them, and the recommendations were made with the sole object of indicating a remedy for the very unsatisfactory industrial condition in which

India now finds herself. No one who has visited Bangalore can have failed to recognise the great pioneering work which Dr. Travers did there; but the fact that he was unable to carry through does not necessarily mean that, under different conditions, possibly determined by past experience, the outcome might not be different. JOCELYN THORPE.

Imperial College of Science and Technology,
South Kensington, London, S.W 7.

Some Poetic Allusions to Phenomena of Plant Biology.

IT is with a peculiar pleasure that one finds observations, ordinarily recorded in the precise words of scientific usage, appearing in the beautiful and fanciful diction of the poets. The following examples may be familiar to many, but I have not seen them mentioned elsewhere in this connexion.

It has been shown by A. R. C. Haas that the soluble pigments in many flowers act as indicators, and give a measure of the hydrogen ion concentration of the sap, which in some flowers becomes less as the petals age and wither. This colour change has been noted by Edmund Spenser, and in recent times by A. E. as follows:

Astrophel.
Transformed them, there lying on the field
Into one floure that is both red and blew,
It first grows red, and then to blew doth fade,
Like Astrophel, which thereinto was made.

The Great Breath.
Its edges foamed with amethyst and rose,
Withers once more the old blue flower of day:
There where the ether like a diamond glows
Its petals fade away.

The first is the imagery of mythology, the second uses the same illustration to contrast the brief life of a flower with the unending procession of days.

Again Tennyson gives us a description of the yew tree in stanza 2 of "In Memoriam," which contains these lines:

O not for thee the glow, the bloom,
Who changest not in any gale,
Nor branding summer suns avail
To touch thy thousand years of gloom.

Beyond this stanza the early edition makes no further detailed reference to the yew. Later editions, however, provide one additional stanza, a new thirty-ninth being intercalated.

Old warder of these buried bones,
And answering now my random stroke
With fruitful cloud and living smoke,
Dark yew, that graspest at the stones

And dippest toward the dreamless head,
To thee too comes the golden hour
When flower is feeling after flower;
But Sorrow—fixt upon the dead,

And darkening the dark graves of men,—
What whisper'd from her lying lips?
Thy gloom is kindled at the tips,
And passes into gloom again.

Here Tennyson guards against the too literal interpretation of "who changest not in any gale," and gives a wonderful description of the liberation of the pollen and its result of many months later, the formation of the red berry, red as a glowing tip on a piece of wood kindled by fire. The berry falls, the glow is quenched, and gloom follows. This natural sequence of pollen and berry, coupled with the use of the word "kindled," so suggestive of a fiery hue, makes it seem impossible that Tennyson can have intended to allude to the lighter green of the young leaves—an explanation which, I believe, has been put forward.

To A. E. again we are indebted for the description of the recovery of turgor in plants wilted by the heat of day, which is contained in "A Summer Night":

The falling of innumerable dew,
Lifts with grey fingers all the leaves that lay
Burned in the heat of the consuming day.

We have all seen the "grey fingers," but it takes a poet to stamp the picture in an untarnishable phrase.

Finally, in "Prometheus Unbound," Shelley alludes to the liberation of oxygen in photosynthesis, imagining that the spirits "Which make such delicate music in the woods" dwell in bubbles, thus:

The bubbles, which the enchantment of the sun
Sucks from the pale faint water-flowers that pave
The oozy bottom of clear lakes and pools,
Are the pavilions where such dwell and float
Under the green and golden atmosphere
Which noon-tide kindles thro' the woven leaves,
And when these burst, and the thin fiery air, . . .

Have we as yet got so very far beyond "the enchantment of the sun" as an explanation?

W. R. G. ATKINS.

Antony, Cornwall,
July 17.

Electrical Properties of Thin Films.

THE mechanical properties of thin films on the surface of water have been the subject of many investigations; yet little is known of their electrical properties. Whilst the electrical properties of those films which are formed on the surface of soluble capillary active substances can be readily investigated, using a method elaborated by Kenrick (*Zeitschr. f. physik. Chem.*, xix. 625), no method, so far as I know, has yet been described which can be applied to films formed by insoluble substances. The following simple arrangement has been designed which has given quite satisfactory results in this case.

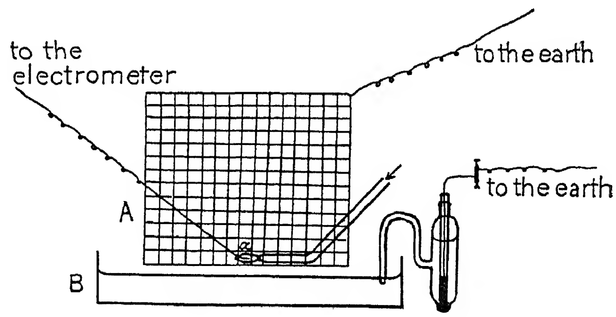


FIG. 1.

A thin platinum wire *a* was heated to white-heat by a minute gas flame in an earthed Faraday cage *A* hung over the surface of water in the vessel *B* (Fig. 1). The platinum wire was connected with a quadrant electrometer, and the water in the vessel with the earth through a decinormal calomel electrode. Between the earth and the electrode, a variable electromotive force could be inserted. The experiments have shown that the potential of the wire follows closely the variations of the potential of the water surface when the distance between the platinum wire and the water surface does not exceed 7-8 mm.

If we put now a droplet of oil on the water surface, the electrometer shows instantly a change of the potential of the wire. In order to compensate this

change a definite electromotive force has to be inserted between the calomel electrode and the earth. In this way it can easily be shown that a monomolecular layer of oleic acid makes the water surface more positive by 0·22 volt, whereas the same effect for lauric acid amounts to 0·27 volt and for olive oil to 0·33 volt. On replacing the water in the vessel by a solution of a capillary active substance, data are obtained which can be compared with those given by the Kenrick method. In this way I have found a positive effect equal to 0·27 volt for 50 per cent. acetic acid and a negative one equal to 0·38 volt for a molar solution of chloral hydrate, whereas the Kenrick method gave for the same solutions in a fair agreement +0·285 and −0·365 volt respectively (*Zeitschr. f. physik. Chem.*, in press).

The experiments are to be continued, and a detailed account will be published in the *Zeitschr. f. physik. Chem.* A. FRUMKIN.

Karpow Chemical Institute,
Moscow, July 3.

The Oogenesis of Lithobius.

MISS S. D. KING in her note on the oogenesis of Lithobius published in NATURE of July 12, p. 52, says:

"Yolk formation is from nucleolar extrusion, of which two phases can be distinguished; first, an early extrusion of particles budded off from the large central nucleolus, which retains its individuality, and, secondly, an extrusion of particles derived from the fragmentation of this nucleolus."

In a paper on the oogenesis of Lithobius now in the press (Proceedings Cambridge Philosophical Society), I have shown that there is no fragmentation of the nucleolus. It can be seen in the most highly developed oocytes obtainable from the ovary as a completely acidophil structure with prominent vacuoles. The nucleus at this stage lies just below the chorion. As to budding of the nucleolus, there are two kinds of nucleolar extrusions: small circular bodies, which generally form the secondary nucleoli, and large irregular bodies, which are first plastered round the nuclear membrane, where they may bud off smaller pieces, and are later detached and lie in the cytoplasm.

Nor is there any direct evidence for the statement that "the later extrusions enlarge after proliferation to form the definitive yolk spheres." All that can be said with certainty is that the nucleolar extrusions precede yolk formation, although a few may exist side by side with yolk spheres.

With regard to the Golgi apparatus, I have definitely established that during fragmentation it undergoes fatty degeneration, and gives rise to fatty yolk, which forms the uppermost area in the centrifuged egg, whereas the true vitelline yolk is thrown down. Both direct and indirect evidence has been adduced in favour of this statement. The fatty yolk is intensely blackened by chrome-osmium alone; with Da Fano it turns brownish. The mitochondria, the nucleus, and a few unchanged Golgi elements form the central area of the centrifuged egg.

In view of the remarkable transformation of the Golgi elements in the oocytes of Lithobius, which is paralleled only in Saccocirrus (Gatenby), and also in view of the egg-like giant spermatocytes of Lithobius, it was considered desirable to extend the investigations to the Golgi apparatus in the male germ cells. No fatty degeneration of the apparatus takes place in these cells. In the spermatogonia the apparatus consists of at least one circular element, in the centre of which is a definite archoplasm. During the remarkable growth phase the circular element proliferates profusely, so that the spermatocytes are full of such elements. Each circular element may also divide in such a manner as to form two very regular crescents, each with an archoplasm. During meiosis the distribution of the Golgi elements is quite haphazard. During spermateleosis all the mitochondria and the majority of the Golgi elements form the tail sheath, but a few Golgi elements are plastered round the anterior face of the nucleus, and probably give rise to the acrosome. VISHWA NATH.

Zoological Laboratory,
Cambridge, July 14.

Approximate Rectification of the Parabola.

RECENTLY I had to ascertain with some precision the length of the curved path of a shot in air at elevations up to 40° as compared with the horizontal range.

The material available was a quantity of trajectories worked out in full detail by "small arcs." The error in summing these small arcs and considering the result to be the length of the curved path was within ±0·10 per cent The greatest heights were also contained in the calculations.

Assuming the parabola of equal angle of projection and of equal height as standard and comparing the actual length, the length of a similar circular arc and the "fudge" formula L = R sec E to this standard, the result is surprising, and is as follows in parts *per thousand*:

Elevation in Degrees	10	20	30	35	40
Parabolic error	0	0	0	0	0
Actual length	+1·0	+4·5	+7·0	+8·5	+8·5
R sec E . .	0	0	0	+0·8	+4·5
Circular arc .	0	+2·0	+10·0	+18·0	+31·0

On comparing notes with professional ballisticians, I cannot find that the "fudge" R sec E was known to Tartaglia, Galileo, Newton, or Benjamin Robins, nor has it yet been found in any modern book on ballistics or geometry. I hit on it myself by pure chance. Can any reader of NATURE supply a reference?

J. H. HARDCASTLE.

13 Charlton Road,
Blackheath, S.E.3.

Electric Charges by Friction.

THE following quotations from a book printed nearly one hundred years ago (Murray's "Elements of Chemistry." Sixth edition, Edinburgh, 1828) bear on the observations of an anomaly in frictional electricity referred to recently in NATURE (June 21, p. 914). "A white silk ribbon rubbed against a black one becomes positively electrified; but if the black ribbon be worn so that the colour is faded, and if the white ribbon be heated, the latter will be found to be negative, and the black positive."

As a result of consideration of a large number of such experiments, M. Coulomb inferred "that where the particles suffered a transient compression, they would be more disposed to become positive; where they suffered dilatation, the tendency would be to the reverse state."

This inference seems to receive support in the recent experiments with rough and smooth ebonite rods. H. E. GOODSON.

38 Chapel Lane, Armley, Leeds,
July 4.

The Radioactivity of the Rocks.[1]

By Prof. JOHN JOLY, D.Sc., F.R.S.

THE subject of the radioactivity of the rocks is one whch offers to the geologist considerations of the first importance respecting the history of the surface features of the globe. To the chemist it offers considerations even more fundamental in character, for it appears to throw a certain amount of light on the past history of the chemical elements during geological ages—knowledge attainable in no other way at the present time.

The fact that the radioactive elements of the uranium family are widely, indeed universally, distributed in the rocks was determined, in the first instance, by the present Lord Rayleigh, who in 1906 published an extensive research on rocks of various kinds. Later it was found that elements of the thorium family are just as widely distributed; and further, it was found that there appears to be a certain well-sustained relation between the amounts of these elements present in igneous rocks when the uranium and the thorium content of the same chemical division of the rocks are compared.

Lord Rayleigh in his earliest paper came to the conclusion that the acid rocks contained more radium than the basic rocks. This result has been confirmed by subsequent work. He found that the mean content of the igneous rocks was considerably greater than that of the sediments. This result, which has also been confirmed, throws light on the high radioactivity of the more slowly collecting oceanic deposits—the red clay and the radiolarian ooze. Similar results have been arrived at for the thorium content of rocks.

I have already referred to the fairly constant ratio which exists in the quantities of uranium and thorium in igneous rocks. When we estimate the uranium from the radium, using the equilibrium factor $3{\cdot}4\times10^{-7}$, we find in basalts about $0{\cdot}44\times10^{-5}$ gm. of uranium and $0{\cdot}9\times10^{-5}$ gm. of thorium. In intermediate rocks the corresponding ratio is 0·76 : 1·64. In the acid rocks (granites) the ratio is 0·8 : 2·0. For acid intrusives it is 1·1 : 2·3. The mean of all acid rocks affords 0·9 : 2·0. In short, we find a ratio which does not vary much from 1 : 2. In individual rock specimens this ratio is often seen to hold; but exceptions are found. It is best revealed in the general means, as, under the conditions, might be expected. To what may this fairly constant ratio be ascribed?

The rate of decay of uranium is nearly three times as fast as that of thorium. Obviously the precise numerical value of the ratio referred to must have been changing throughout geological time and must continue to change. The uranium will have dwindled to insensible amounts long before the thorium. But the fact that there appears to be a numerical ratio which is preserved through the chemical divisions of the rocks, although the actual amounts involved may differ largely, must be significant of some controlling condition.

Now if all rock families derive their origin from some world-magma by certain processes of differentiation which do not select between the parent radioactive substances, uranium and thorium, then we can account for the observed constancy of ratio. For if granites, for example, take from the parent magma a certain quantity of both the parent radioactive elements without disturbing their primal ratio, and if diorites and syenites take a different quantity, but still without disturbing the original ratio, then in subsequent ages the ratio of uranium to thorium, varying in the same manner both in granites, diorites, syenites, and the mother magma, will continue to be alike in all.

This subject naturally leads us to the interesting conclusion reached by Lord Rayleigh that the first formed silicate in rocks—zircon—is most exceptionally rich in radium. We seem to know little about mineral genesis in rocks. Hence we find here a tempting field for speculation. The oxide of zirconium is isomorphous with the oxides of uranium and thorium. It seems probable that herein is some explanation of the accretion by zircon of radioactive elements from the magma. The radioactive centre thus originating becomes the centre of a minute field of intense ionisation. These conditions may be supposed to be favourable to the crystalline growth of molecules around it. The radioactive nuclei are small and their field of influence is restricted, but the surrounding chaos is trembling on the verge of equilibrium and there is unlimited time. Of the chemical effects of radioactivity Soddy says: "The great chemical reactivity of otherwise inert substances in presence of the radioactive materials must always be remembered in the interpretation of their action." In fact it has been supposed by workers on this subject that there is first a dissociation of molecular aggregates and temporary formation of free atoms under the influence of the radiations, rendering the substance highly reactive, as in the nascent state. Much experimental evidence for this statement might be quoted. In some such way the growth of mica or hornblende around zircons may originate.

This concentration of radioactive elements gives rise to the radioactive haloes found in certain rock-forming minerals of early consolidation—notably the brown micas. These very beautiful manifestations of radioactivity in the rocks raise many questions. It is remarkable that the earlier observers regarded these minute objects as organic in origin. The only basis for this view appears to have been their behaviour when the containing mineral was heated to a high temperature. The halo then vanished or lost all definition.

Far-fetched as such an explanation may appear, we must remember that the real history of these objects was at that period absolutely undecipherable. It required a generation of scientific discovery and the brilliant advances which brought to light radioactivity, the transforming atom, and the phenomena of material radiation, before the real explanation was possible. Sollas, before the period of these discoveries, suggested that they were in some way caused by the presence of rare elements in the nuclear zircon which is in most cases to be found in the halo. To go any nearer to the truth was then impossible. The

[1] Hugo Müller lecture (slightly abridged), delivered before the Chemical Society on February 28.

wonderful similarity of dimensions and structure revealed by these objects seems to have escaped notice.

With the advent of radioactivity the explanation is simple. In this new domain, which borders at once upon radioactivity, chemistry, petrology, and geology, many curious facts have come to light. For the first time we can determine by direct visual observation the presence of radioactive elements in the rocks, and, given the halo, a single measurement of its radius tells us at once whether it was generated by uranium or by thorium. Some haloes there are which are generated in a curious way from the passage of the gaseous emanation of the uranium family which has wandered from the radium whence it originated and has become occluded in certain nuclei. These then have become centres of development of haloes possessing characteristic dimensions telling of their exotic origin. These are the only three sorts of haloes reconcilable with the known sources of radioactivity.

It is desirable to recall here the foundations upon which our knowledge of haloes is built. The fundamental assumption is that the α-ray is the all-sufficient source of the halo. For example, the atomic *débâcle* from uranium to lead takes place in fifteen stages. Of these, eight are attended by the expulsion of a helium atom as an α-ray carrying a charge of two units of positive electricity. The range in air of these rays varies from 2·7 cm. (in the case of the ray from uranium-1) to 6·97 cm. (in the case of radium-C_1). If the atomic disintegration occurs within a mica flake, these ranges are reduced some two thousand times.

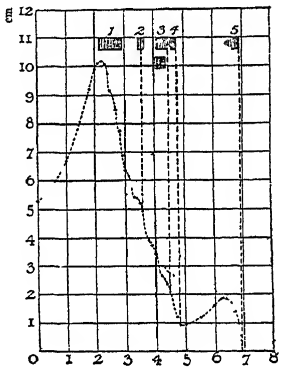


FIG. 1.—Ionisation curve for uranium haloes.

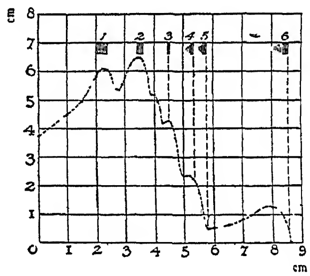


FIG. 2.—Ionisation curve for thorium haloes.

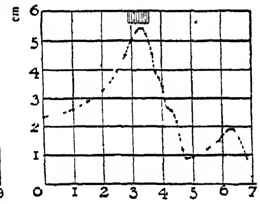


FIG. 3.—Ionisation curve for emanation haloes.

We know something about what happens along the track of the ray in gases. The particles of the gas are ionised. Bragg plotted the curve of ionisation. He found that the curve was alike in form for α-rays of long range and of short range, and that the ionisation rapidly increased just before the ray lost so much of its kinetic energy as to be no longer effective. The range of the ray is measured to the point where—effectively—it comes to rest.

Suppose now that in the brown micas the ionisation is attended with certain chemical changes—for example, affecting the iron present—so that the mica is darkened in colour. Then this darkening intensifies along the path of the ray and is darkest just at the approaching end of its trajectory. If uranium is contained in a minute particle—a crystal of zircon most generally—the eight rays will all act upon the surrounding mica within a certain spherical volume which has the zircon at its centre and the outermost boundary of which is defined by the path of the helium atom discharged from radium-C_1, the most penetrating of the rays. The radius of the uranium halo will therefore be about the two-thousandth part of 6·97 cm.—or, say, 0·035 mm. In the case of an emanation halo the outer dimension will be the same, for the penetrating ray of radium-C_1 decides its boundary, but the effects of the four least penetrating rays of the uranium family will be absent. If thorium be in the nucleus, then seven rays operate on the mica and the outer *dimension is determined by the range of thorium-C_1*, which is 8·62 cm. in air and becomes 0·041 mm. in biotite. Uranium and thorium haloes are thus readily distinguishable.

To determine the inner features, we lay out the ionisation curves of the eight rays of the uranium family, or the seven rays of the thorium family, or the four rays which generate the emanation halo and add the ordinates at sufficiently close distances. This gives us the integral curves of ionisation, and these curves we find bear close comparison with the actual halo. The apices of the curves correspond to the rings of darkened mica which lie around the nucleus. The depressions of the integral curve are depicted in the mica as annular areas of feeble darkening. But here a difficulty arises. Our method of arriving at these curves assumes that the rays affect the mica as if they travelled in parallel lines. But in fact they diverge, and when we plot the integral curve so as to allow for this divergence, we get a curve not at all accordant with the halo.

In order to explain why the halo does not exhibit the effects of the divergence of the rays, we may assume that something like photographic reversal or solarisation occurs when one ray traverses the path followed by a preceding ray. This weakens the density of the inner parts more than it affects the outer parts of the halo, and it follows that the ultimate effect is much the same as if the rays had been parallel. This view also explains the early appearance of the outermost ring of all; for a minimum of reversal affects this. *It is not at all an improbable assumption that reversal* plays an important part in the generation of the halo as we see it.

We see, then, that we can foretell the appearance and dimensions of the inner parts of a halo according as it originates from uranium, thorium, or radium emanation. If we find haloes not in accordance with these dimensions, we must conclude that we are dealing with new radioactive elements, unless some means of reconcilement be forthcoming. Herein we find an important application of the radioactivity of the rocks to the advance of chemical science.

When we look at the integral curves of uranium, thorium, and emanation haloes, we see that in the case of uranium and emanation (Figs. 1, 2, and 3) a single conspicuous crest occurs which must appear in

the halo as an inner ring of small radius. In the case of thorium, two such crests appear close together. Those early rings are the first appearance we find. Their measurement will tell us what elements we are dealing with, although the halo is only in an incipient stage of development. Such rings are found well developed and easily measurable around nuclei of extreme minuteness.

We possess in haloes a means of identifying the presence of radioactive substances in rocks which much transcends in sensitiveness any other known method. The electroscope transcends in sensitiveness chemical gravimetric methods of detection many thousands of times. The billionth of a gram of radium per gram of rock may be detected by the electroscope. But we may have a zircon nucleus of the five-thousandth of a millimetre in diameter. We may suppose it endowed with a radium richness twenty-five times as great as obtained in the richest zircons measured by Lord Rayleigh. Then the mass of radium involved is only 3×10^{-18} gm. or the millionth of the billionth of a gram. Such nuclei may show a perfectly measurable and identifiable ring.

The reason for this extraordinary sensitivity is obvious. The halo is always old—often very old, and through all the successive ages of geological time the ionisation effect is slowly adding up. It is, in fact, not found in the younger rocks. We perceive the final effects of such feeble radiation exactly as we may detect on the photographic plate, after long exposure, stars which are for ever invisible to the eye.

On this account, also, the halo is important to chemical science. It gives us a means of exploration, almost uncanny, into the past history of the chemical elements. By its help we may answer questions which may not be approached in any other way. We can tell if the known radioactive elements formerly differed in their mode of disintegration or if other radioactive elements existed in the remote past. The important question as to whether during geological time radioactivity has been a diminishing phenomenon may be answered by the halo. For the halo is, in fact, a sort of hieroglyphic, a writing in the rocks, which admits of interpretation based on to-day's experience of what radioactivity involves. All this is equally important to the geologist. For he wants to know, as vital to the past history of the surface changes of the earth, whether the known radioactive elements evolved thermal energy as they do to-day, or whether in the past notably more or notably less energy from this source affected the earth.

That halo-reversal is an actual and definite phenomenon seems certain. We cannot, indeed, be sure that it is quite similar in character to photographic reversal; but it acts much in the same manner and there is considerable probability that the two phenomena are very much the same in character.

The theory of photographic reversal may be stated in a few words. The action of light on the photographic plate is photo-electric in nature. Electrons are released from the silver halide each bearing a certain quantum of energy derived from the absorbed luminous vibratory energy. These electrons penetrate a certain distance from the illuminated point, which remains positively electrified, and create around it a negative electrostatic field. This ionised system constitutes the latent image. It may persist for months or years. If we apply a developer, the energy, potential in the latent image, is expended in promoting chemical interaction between the ionised silver halide and the developer. In this process the silver is liberated and is built up in the ionised region to form the visible image. Such is the typical course of events in the case of normal exposure.

Suppose, however, we prolong the exposure or use a very powerful source of illumination. The electrostatic field around the illuminated point grows stronger and stronger until finally the insulation breaks down. There is then re-combination of positive and negative ions and the plate is restored to its original state. At this stage development gives no visible image. The image has, in fact, been reversed, the former latent image having disappeared. This is the first

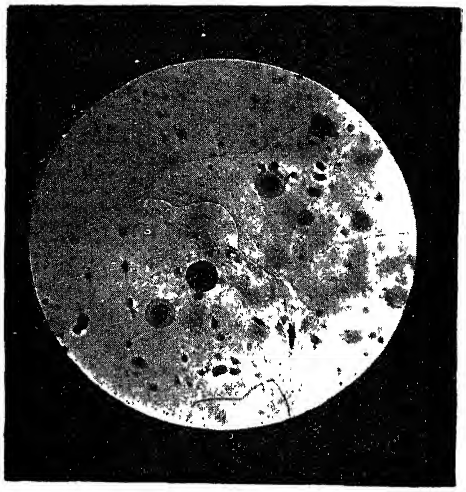


FIG. 4.—Uranium haloes in various stages of development. ×76 From Leinster Granite (Devonian).

reversal. If exposure be continued beyond the point of reversal, the original phenomena are repeated and a new latent image is formed like the first one, and so with continuous exposure the events in the film are repeated. The successive reversals may be demonstrated by exposing for increasing periods consecutive areas of a photographic plate.

The α-ray carries a certain quantum of energy according to its initial velocity when it leaves the transforming atom. The ray consists of a helium atom carrying two unit positive charges. In its passage through the mica it does work of ionisation. The original chemical bonding is disturbed, and under the influence of the ionisation, atomic systems are built up which are stable just as the latent image is stable. But it is conceivable that a second ray traversing the same or a nearly adjacent region may destroy this equilibrium and cause a reversion to the original equilibrium or to some new state of atomic equilibrium. The former case would result in the restoration of the original state of the mica: the latter may involve a new chemical bonding. As a matter of observation the new bonding appears, at least in some cases, to result in bleaching of the mica. Possibly successive "images" and reversals may occur. In experiments

on the age of haloes, Rutherford produced very intense coloration in biotite by exposing it to strong α-ray radiation. It might be possible to obtain some definite knowledge as to what actually happens by continuing such intense α-radiation for long intervals of time.

In the oldest rocks we certainly find plentiful evidence of bleaching around radioactive nuclei. If these particles happen to be sufficiently isolated, we get a

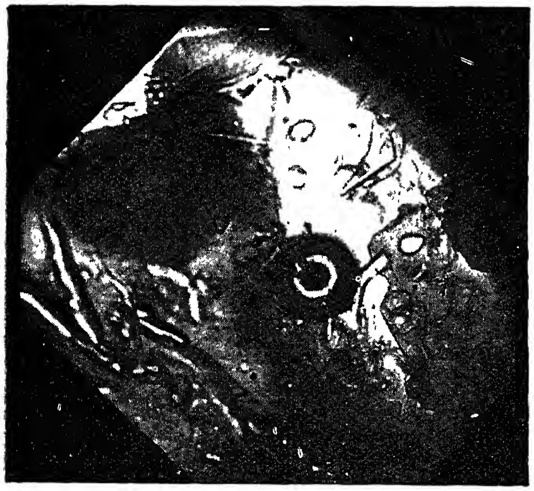


FIG 5 —X-halo ×256 Radius = 0·0294 mm Ytterby mica (Archæan)

halo which may show some of its circular bands not as darkened areas but as colourless areas. If the particles are arranged in line and are sufficiently close together we get a bleached band, in the axis of which the particles are distributed. Outside the bleached band we see the effect of normal exposure in the darkening of the mica. Sometimes we find a halo very beautifully reversed or bleached where normally there would be successive dark rings.

In the study of haloes we have to bear other conditions in mind besides these changes brought about by reversal. Side by side in the oldest mica, embryonic haloes and "over-exposed" haloes are to be found, the former merely as a delicate ring of small radius surrounding a very minute nucleus, and the latter as a disc sometimes of almost impenetrable blackness (Fig. 4). Why is this? The answer is simple. The stage of development attained depends on two conditions: the age of the rock and the radioactive richness of the nucleus. These conditions correspond to duration of exposure and strength of illumination in the case of photography. Another obvious fact must also be borne in mind. The halo presented to us in the flake of mica may be a section off the centre of the halo-sphere, for serial sections of haloes in mica demonstrate that they are spherical. Rock sections revealing haloes contained in sections crossing the cleavage support this conclusion.

The phenomena attending bleaching have also to be held in view when studying these radiographs in very ancient rocks; for it may happen that certain outer or inner features may be obliterated thereby. In drawing the conclusion that a halo cannot be reconciled with known varieties. further evidence than the external dimensions of a few examples is required.

In the micas of Ytterby, which are of mid-Archæan age (pre-Huronian), I have found haloes which cannot be reconciled with haloes originating from known radioactive elements. These haloes I have called X-haloes (Fig. 5). There appear to be two varieties. I distinguish them as X_1- and X_2-haloes. They are fairly numerous. Sometimes, while free from any sign of bleaching, they look pale and washed-out. This is due possibly to some effect of over-exposure, just as an over-exposed plate lacks strength. Or, possibly, it is due to the remarkable metamorphic effects which this mica has generally experienced. In places such faded haloes may crowd together so as to overlap. They vary somewhat in dimensions, both externally and internally. But this effect may be due merely to different stages of development. Generally they consist of a central dark disc surrounded by two or three consecutive wide bands, the innermost one of which may be reversed. I do not think it is possible to ascribe X-haloes to thorium. Moreover, the thorium haloes which occur in this mica are always easily identifiable.

Here, then, is an example of the peculiar use we may make of these radiographs. If my conclusions are correct, we here find evidence either for an unknown element which has radioactively vanished off the earth, or for an undiscovered radioactive element.

In this same mica of Ytterby—but of extreme rarity—certain haloes of minute dimensions and all completely reversed or bleached also occur. I have called these "hibernium" haloes (Fig. 6). The majority are very uniform in dimensions, the radius being 0·0052 mm. A larger size—less abundant—seems present. These are closely 0·0086 mm. in radius. Now the earliest inner ring of a thorium halo is 0·011

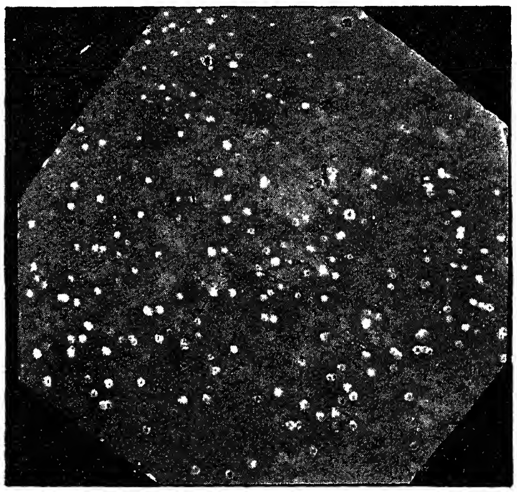


FIG. 6—"Hibernium" haloes Radii, 0·0052 mm. and 0·0086 mm. ×106·4. Ytterby mica. (Archæan)

and of a uranium halo 0·014. If the conversion factor in this mica be taken as roughly 2000, the range in air of the rays responsible for the smaller hibernium halo would be a little more than 1 cm.

Each of these minute halospheres contains a nucleus accurately centred. If two such nuclei are sufficiently adjacent, the resulting halo is of the form of intersecting spheres. Three adjacent nuclei may give rise to a pear-shaped halo. There seems no doubt that their development is controlled by the nucleus in every case. As the bleaching is no objection to their radioactive origin, but in fact supports it, I see no alternative to the view that they are true haloes but of remarkably small dimensions. A prolonged search for other swarms of these haloes has proved unavailing.

It is of interest to notice that these haloes may be—not impossibly—generated by one of the known elements, for they must originate from a substance so feebly radioactive that no known method of observation would detect its radioactivity. This follows from the extremely small trajectory of the responsible α-rays. It will be remembered that Rutherford long ago pointed out that there existed a connexion between the initial velocity with which an α-ray was expelled and the period of the element giving rise to it. Geiger and Nuttall showed that a definite relation was deducible, most simply shown by plotting the logarithm of the constant of transformation against the logarithm of the range of the α-particle. Thus treated, the elements of each radioactive family are distributed approximately along a specific right line, and the lines for the uranium, thorium, and actinium series are sensibly parallel. From this investigation Geiger inferred that elements emitting α-particles of very small ranges would possess so slow a rate of transformation that no known instrumental method would reveal the fact that they were radioactive.

The age-long integration effected in the halo, however, can reveal radioactive phenomena far beyond the power of instrumental measurement. It is, therefore, not impossible that in these haloes we detect the radioactivity of some of those rare elements which this mica first revealed to science.

Lastly, one conspicuous fact is everywhere forced upon us in our studies of haloes—the scarcity of visible radioactivity in the rocks and the immense antiquity of that which we observe. In the absence of this mode of tracing radioactivity into the past, we might quite reasonably have argued that in former geological times many of the known elements were in process of radioactive genesis. The study of haloes rules out this view. Again, what radioactivity we are acquainted with has not originated in recent times. It dates back into the oldest rocks. The appearances which I have endeavoured to describe show this clearly. The reversed or blackened-up haloes of the Archæan are entirely different in appearance from those of Lower Palæozoic age. Indeed the geologist may by these appearances derive strong evidence as to the relative antiquity of the rocks he deals with. We arise from halo-study more than ever impressed with the immense age of the elements, and yet we know that some of them are to-day perishing off the earth and that a definite period is placed to their existence. What the halo ultimately shows is the remoteness of those past ages which probably witnessed the evolution of the elements.

The Malarial Treatment of General Paralysis.

FOR many years it has been realised that the intercurrence of an acute specific fever, such as erysipelas, in cases of general paralysis of the insane, is frequently followed by marked improvement in the general condition, and attempts have been made to procure remissions by the induction of an artificial pyrexia. In 1917, von Jauregg introduced the method of inoculation with malaria. About 5 c.c. of blood are taken from the vein of a patient suffering from benign tertian malaria and immediately injected subcutaneously, intravenously, or intramuscularly into the general paralytic. The average incubation period is about ten days, after which typical malarial attacks appear. When the patient has passed through ten or twelve attacks, the malaria is arrested by the administration of quinine and a course of neosalvarsan is given. Improvement is observed soon after the cure of the malaria, and in early cases of general paralysis the patient may become as capable as before the onset of the disease. Von Jauregg obtained prolonged remissions in more than fifty per cent. of his cases, the most noticeable features being the cessation of fits, better articulation, and general improvement in the mental and physical conditions. Other European observers have reported equally good results; in a series of 296 cases, Gerstmann found remissions in sixty-eight per cent.; Weigandt obtained improvement in forty-four out of fifty patients. In Great Britain the number of patients hitherto treated is small; Worster-Drought found improvement in all except one of twelve early cases; in a series of asylum patients, in whom the disease would be more advanced, improvement has been reported in six out of nine cases.

In dealing with syphilis of the central nervous system, the cerebro-spinal fluid affords an indicator of the inflammatory changes taking place in the brain and spinal cord, and the efficiency of treatment may be estimated by the resultant alterations in the fluid. So long as a positive Wassermann or any other abnormal reaction is given by the fluid, it cannot be considered that the disease has been eradicated. In cases of general paralysis, treatment by drugs has very little influence on these reactions; neither has it been found that inoculation with malaria, although producing remissions, has any effect in diminishing the intensity of the Wassermann and colloidal gold reactions. No patients have been observed for sufficient length of time to determine what period of improvement may be anticipated, but it must be remembered that spontaneous remissions are common during the course of general paralysis, and that relapses invariably follow. In view of the persistence in the cerebro-spinal fluid of the evidence of active syphilis, it cannot be expected that remissions following malarial inoculation will differ from those which arise spontaneously.

In our present state of knowledge, only speculation is possible concerning the mode of action of artificial pyrexia. Drugs, and probably specific antibodies, penetrate with great difficulty into the central nervous system; it may be that pyrexia with leucocytosis in some way increases the accessibility of the actual nervous tissue to the passage of substances from the blood-stream. Purves-Stewart suggests that the remissions are due to the destruction in the febrile reaction of some of the toxins affecting the cerebral cells, the specific organism of the disease being unaffected. He has published descriptions of two cases of general paralysis treated by malarial inoculation, followed by a course of intra-cisternal injections of salvarsanised serum. In the resulting remissions the cerebro-spinal fluid became completely normal in one case, and the pleocytosis was markedly diminished in the other. This result is of great importance in indicating that malarial inoculation, combined with a specific anti-syphilitic treatment which can reach the cerebral cortex, may prove to be a means of completely arresting the disease.

Inoculation with malaria is not entirely without drawbacks; there is a definite risk of the parasite being conveyed to other persons by the mosquito; the Board of Control has issued a letter to asylum superintendents recommending a number of precautions to be adopted against this risk. In advanced cases the attack of malaria may hasten the fatal termination, but, in view of the hopeless prognosis of general paralysis, this mortality cannot be considered as a contra-indication to a treatment which in early cases produces such marked remissions. The serious nature of the disease, and the complete failure of anti-syphilitic treatment to have any effect on its course, demand that every endeavour should be made to investigate and perfect a method which offers some hope of improvement.

Obituary.

Sir William A. Herdman, F.R.S.

The sudden death of Sir William Abbot Herdman on July 21 will be deeply regretted by naturalists in many parts of the world. For several years his general health had been bad. His only son, George, was killed in the battle of the Somme, and this calamity accentuated an illness from rheumatism which left him partially crippled and with serious heart weakness. He had begun to shake off the rheumatism when his wife died after two days' illness from pneumonia, and since then his health continued to be bad. He had gone to London on the day that he died to be present at the wedding of his daughter, and had arranged to leave Liverpool three days later for the British Association Meeting at Toronto.

Herdman was born at Edinburgh in 1858, and was educated at the High School and University in that city. He graduated in science in 1879, and was for a short time assistant to Sir Wyville Thomson. Then he went to the *Challenger* office, where he worked under Sir John Murray, and began the description of the Tunicate collections, a work which he finished at Liverpool. He went to the latter city in 1881, when the University College was established, as the Derby professor of natural history. In 1919 he retired from his chair (then that of zoology), and became professor of oceanography, a post which he held for a year, when he retired as Emeritus Professor. His connexion with the University of Liverpool did not, however, cease in 1921: he was a member of council and of various committees, and during the Lent term of 1924 he was acting vice-chancellor in the absence, on sick leave, of Dr. Adami. He had a room in the Department of Zoology, and he was there almost daily. At the time of his death he was engaged in a research on the morphology of Ramulina.

During the latter part of his life Herdman was a comparatively wealthy man, and (with his wife) was a generous donor to the University. He endowed the chair of geology in 1916, and that of oceanography in 1919. In 1923 he gave the University a sum of 20,000*l.* to assist in the building of a new department of geology. He endowed an exhibition, and he bought and furnished a building at Port Erin as an institute and club for fishermen. For the last dozen years of his life he had become greatly attached to Port Erin, where he owned a house at which he resided during a considerable part of each year. His interest in Manx affairs was strong, and he was practically responsible for the foundation of the new Government Museum at Douglas.

Herdman's life-work was, of course, marine biology: that he began by a series of dredging expeditions in the Firth of Forth; developed in the *Challenger* office, and continued when he went to Liverpool. There he found a small group of amateur naturalists whom he organised as the Liverpool Marine Biology Committee; he outlived nearly all these original workers. They prosecuted active, systematic, biological investigations in the Irish Sea region, at first hiring steam tugs for their dredging and trawling expeditions. Then they fitted out a biological station at Puffin Island, in Anglesey, and later built two stations at Port Erin, in the Isle of Man. In 1892 Herdman organised the scientific work of the Lancashire Sea Fisheries Committee, and persuaded the latter body to found the Fisheries Laboratories at the University of Liverpool, and at Piel in Barrow. The result of these activities has been a very satisfactory biological survey of the Irish Sea, summarised in five volumes of a "Fauna and Flora," and a long series of papers on fishery subjects written by Herdman and his colleagues, and published by the Fisheries Committee. This work was, at first, financed locally, but, later, it was supported by government grants with results that have not been satisfactory. The local contributions have tended to decrease; there has been an unnecessary control over expenditure, and an insecurity of tenure of post for the scientific men employed.

In 1901–2 Herdman went to Ceylon for the greater part of a year, at the request of the Colonial Office, to study the pearl-oyster fisheries. He went out again

a year or two later at the request of the syndicate of pearl fishers, which had in the meantime leased the fishery rights from the Government. The results of these expeditions was a very complete biological survey of the pearl banks, published in five volumes by the Royal Society, and an hypothesis of pearl formation which has given rise to much controversy. He was, in 1892, elected a fellow of the Royal Society, and was its foreign secretary in 1916–20. He was president of the Linnean Society in 1904, president of Section D of the British Association in 1895, and president of the Association at the Cardiff meeting in 1920. During the war years he was chairman of the Grain Pests (War) Committee of the Royal Society. He was a member of various official commissions and advisory committees, and gave expert testimony before other similar bodies. He received many honours during his lifetime: he was a D.Sc. and LL.D. of the University of Edinburgh, and a D.Sc. of the Universities of Harvard, Durham, Sydney, and West Australia. He was made a C.B.E. in 1920, and was knighted in 1922.

Herdman was, above all, a field naturalist and systematist of the type which seems now to be passing away. His knowledge of species of animals was extraordinarily good: helpful (and at times embarrassing) to his colleagues and assistants. This fine zoological knowledge was of immense value to him in his fishery investigations. He was adventurous, very active, and inclined to "rough it" until middle age: he and his friend Isaac Thompson for a time went regularly to Port Erin Bay to swim during the Christmas vacations. He was a keen traveller and yachtsman, and had visited most countries in the world. For many years he owned small steam vessels which he worked himself up the west coast of Scotland, round St. Kilda, and through the Orkneys and Shetlands on his trawling and plankton expeditions. He always had strong interest in archæological investigation, and with his friend P. C. Kermode did a good deal of excavation in the Isle of Man, while at one time or another he had visited most of the places of anthropological interest in the continent of Europe. In his own home he was at his best: an accomplished talker, most hospitable and good-humoured. On his fiftieth birthday his family presented him with a pipe, and after that he became an inveterate smoker. While his interests were thus very wide, he was first and last a marine biologist, both as an investigator and an expositor, and it is in this direction that his influence was most widely manifested, and will be most sadly missed.

J. J.

MR. EDWIN THOMPSON, who was one of the local honorary secretaries for the Liverpool meeting of the British Association last year, sends the following tribute:

Sir William Herdman was known throughout the world as a great oceanographer. There are thousands who, in addition, knew him as a delightful personality, and there are others who had the privilege of knowing him as the kindest, most cheery, most breezy and sympathetic of men. To have known Sir William Herdman personally was an education in the highest sense of the word; he knew and could teach others how to work and how to play, but he never knew what it was to waste time. The short memoir he wrote about his son, George, who was killed in the War, was, I think, an inspiration to every boy who read it, and I always wished that it had been made public, and I feel that Sir William Herdman's life, if it is ever written, will be an inspiration to every man whether he be interested in science or not.

When Sir William Herdman took a holiday it was to work, and I have had the pleasure of seeing him at sea working with the late Sir John Murray, Haeckel, and others, and also years ago have seen him organise children's parties with an understanding with which one does not usually credit great men of science; he might, in fact, have been the author of "Peter Pan." No man was ever made to feel a fool by Herdman, and it is only a great man who has that attribute. It needs a man with a big brain to lecture on scientific subjects to a large audience in such a manner that the subject is clear to every one, even the least intelligent. Sir William Herdman had this power in an extraordinary degree.

His last years were full of sorrow, but with his characteristic pluck he never let others see the sadness in his heart. The strain had told upon him, however, and he knew every time he went upstairs that he might not reach the top alive, but he did not let that interfere with his work or the pleasure he gave to others.

He died suddenly as he would have wished, without a long illness, which to him would have been a terrible trial. His friends, Liverpool, and the whole world have lost a great man, and those who knew him intimately can to a small extent realise the sadness felt by his three daughters and their pride in having such a father. I would just like to tell how he died, as there were many garbled reports, which gave rise to misunderstandings. He travelled to London on Monday, July 21, and gave a little family dinner on the eve of his daughter's wedding. Before going to bed he went out for a short stroll, as was a very frequent custom of his, and in the street he had a heart attack. Fortunately, a woman was passing at the time, and seeing him in distress helped him into the nearest house, which was a small hotel; but by the time the doctor had arrived he was dead. The doctor then sent for the police, who identified him by papers in his pockets. It is tragic that his family were not with him; but it is far more tragic that the false reports should have caused any misunderstanding or been misinterpreted by those who did not know him.

WE regret to announce the following deaths:

Miss K. A. Burke, assistant lecturer in chemistry at University College, London.

Prof. Heinrich Precht, who was closely associated with the German potash industry and contributed many important investigations in this field, aged seventy-two.

Prof. James Seth, professor of moral philosophy in the University of Edinburgh from 1898 until a few weeks ago, on July 24, at sixty-four years of age.

Current Topics and Events.

RECENT criticism of the British Museum Bill fully justifies the comments in our issue for July 5. Sir Hercules Read, as an ex-officer and former trustee of the Museum, in a letter to the *Times* of July 26, emphasises the point that the objects in the national collection are not duplicates, and that the temporary removal of any specimens other than those of trifling interest would disorganise the exhibition and study series, and would add to the difficulties of the serious investigator. The Trustees, who did not ask for this Bill, would in most cases escape from a difficult or delicate position by exercising their discretionary veto. On the other hand, the provincial museums object to the Bill on two grounds: the categories of permissible loans are not those which they particularly desire, and the conditions imposed are onerous if not impossible. The Museums Association has therefore passed a resolution of protest, and has once more called for a Royal Commission to inquire into the whole question of the national organisation of museums. The resolution, which has been sent to the Prime Minister, is as follows: "This Association regrets that the British Museums Bill No. 2, promoted in the interests of provincial museums, should have been introduced without consulting the body which represents those museums and knows their needs, and expresses a hope that the Prime Minister will be so good as to receive a deputation from the Museums Association, which would explain the urgent necessity for the appointment of a Royal Commission to inquire into the work of all the museums of this country."

THE continued closing of the Museum of Practical Geology, London, was discussed at the meeting of the Museums Association last week, and a resolution upon the subject was passed, to be forwarded to the president of the Board of Education. A question asked in the House of Commons on Monday by Major Church, secretary of the National Union of Scientific Workers, elicited some interesting information on the matter. The question was: "To ask the First Commissioner of Works if he can state how long the Geological Museum will be closed for repairs, in view of the importance of the museum to the nation; and will he state why the structural alterations and repairs now being undertaken were not commenced before." In reply, Mr. Jowett, First Commissioner of Works, said: "It has now been decided to proceed with the erection of a new building at South Kensington to house the offices of the Geological Survey and the Museum of Practical Geology, and a Supplementary Estimate for the provision of funds for this purpose is being presented to the House at an early date. The repairs required to the present building to enable it to be reopened to the public are not being proceeded with, but the administrative work of the Geological Survey will still be carried on, and the public will have access to the Library and Map Room. As regards the last part of the question, the execution of the structural alterations and repairs was suspended pending a decision as to the future of the Museum."

THE annual meeting of the Imperial Cancer Research Fund was held on July 23, when the twenty-second annual report was presented and adopted. The report discloses satisfactory steady progress. The finances are sound, though half the annual income comes from subscriptions and donations. The new laboratory at Mill Hill, adjoining the farm of the Medical Research Council and due to the beneficence of the executors of the late A. C. Stroud, has been erected, and the laboratories at Queen Square continue to make the sound contributions to our knowledge of the biology of cancer which has always characterised their activities. After prolonged discussion the Fund has found a means of co-operating with the British Empire Cancer Campaign through the appointment by the Royal Society and Medical Research Council of an advisory committee which will advise the Campaign on the allocation of funds for investigation. The Middlesex Hospital, the Cancer Hospital, and the Fund have also nominated representatives on the grand council of the Campaign. It is hoped that by this arrangement the newest organisation for the investigation of cancer may have the advantage of the experience gained through many years by the older bodies.

ACTIVITY in the experimental investigation of cancer has recently centred largely around the relation between certain forms of long-continued skin irritation—notably by tar—and the development of malignant tumours One of the most noteworthy contributions to the same topic, but from the observational side, is contributed by Dr. Alexander Scott, of Broxburn, who has practised for many years among the operatives in the Scottish shale oil works, to the eighth scientific report of the Imperial Cancer Research Fund. We have here a singularly exhaustive study of the inflammatory conditions of the skin brought about by the repeated irritation of crude paraffins and the conditions under which cancer develops in the affected areas of skin. Dr. Scott's observations, which are illustrated by a large number of illustrative photographs, are particularly valuable, because they comprise the history of nearly twenty-five years—a continuity much needed and so often lacking in clinical studies. They bring out clearly the close parallelism between paraffin cancer in man and experimental tar cancer in mice, especially in respect of the length of the prodromal stages and the course of the disease after tumour growth has started. As a result of his work, preventive measures have been installed in the industry: fresh cancers will no doubt develop for some time, as they do in mice, as the result of past irritation, but in the end his pictures will—or ought to—become a unique historical record of something which no longer exists.

"EDUCATIONAL HARMONICS" is the phrase in which the *Times* sums up the character of the debate in the House of Commons on July 22 on the education estimates. With one or two exceptions, the speakers made no attempts to use the debate as an opportunity

for scoring points for their respective parties. There was general agreement that the problem of adolescent education is of paramount importance, and Mr. Fisher and Mr. Wood were to that extent at one with Mr. Trevelyan in his proposal that for the next few years extraordinary efforts should be made, whatever political party may be in power, to provide for a great increase in the number of secondary school pupils. Mr. Trevelyan suggested that their number, which is already double what it was only a few years ago, should be again doubled within the next ten years. He is less sanguine than Mr. Fisher as to the potentialities of day continuation schools, and laid less stress than Mr Wood on the importance of central schools, but is willing to support local efforts to develop either. There was no discussion of educational aims, and no revival of the proposal made two years ago for a commission of inquiry into the subject, yet, as Mr. Wood remarked, the mere expenditure of much money will never be enough unless the system be right, and unless we know where we are going and what we want to get out of it. Mr Trevelyan's assumption that "there could be no difference in the main objective in education of succeeding governments" may be convenient for preserving harmony in parliamentary debates, but there is little else in its favour. An authoritative statement on the subject commanding general respect would do more to promote real efficiency than the expenditure of many millions, and is doubly desirable in view of the anticipated great expansion of secondary education.

MR. HOOVER, the Secretary of Commerce, U.S.A., in addressing the Izaak Walton League at Chicago in April last, spoke of the attitude that a good government ought to observe in its consideration of fishery problems. Thousands of generations of free fishermen have established their tradition to catch unlimited fish, but now this tradition encounters the spirit of modern industry. There is over-fishing and depletion, so that already the systematised fishing trade, with the "demonic assistance of the tin can," is rapidly destroying the Pacific salmon rivers Long ago, villages situated on rivers and seashores established a right to deposit their waste products on the nearest stream or foreshore. Little harm was done originally, but now the modern factory, the great city with its sewerage system and the new oil-driven vessel, are rapidly making tidal rivers and shores incredibly foul, so that another ancient privilege has become incompatible with a fishing industry that seeks to develop as others have done Finally, the conflict between federal government and local autonomy (as represented by the American States, or the provincial systems of regulation in Great Britain) has, so far, led to confusion of policy and waste of effort. To these problems, Mr Hoover asks the fishery administrators to bring the contemplative mind, the faith and optimism, and the patience and reserve that come to the followers of Izaak Walton; and, one may add, without any suspicion of cynicism, he asks in vain, for the qualities he postulates do not seem to come to those who look at fishery questions through official windows.

THE leading part taken by Messrs. Chance Bros. and Co., Ltd., in the development of optical glass manufacture and their successful efforts during the War to meet the enormously increased demands are well known. These, however, form only a small part of this firm's contribution to the development of glass manufacture during the last hundred years. In 1824 Robert Lucas Chance purchased the works of the British Crown-Glass Company at Smethwick, and thus provided the nucleus round which the modern works of Messrs. Chance have grown. Ever since then, the name of Chance has been intimately associated with the history of glass making in Britain. The firm's first achievement of outstanding importance was the introduction into England, in 1832, of the manufacture of sheet glass. This was soon followed by the production of rolled plate and later of "figured rolled" glass. In 1840 the firm inaugurated the manufacture of thin glass for microscope cover-glasses, which greatly extended the possibilities of accurate microscope work. For many years Messrs. Chance have provided a large proportion of the world's supply of glass for spectacles, while recent developments include the production of heat-resisting glasses for illuminating ware and of chemical resistance glass for laboratory ware. An interesting record of the firm's activities and achievements is contained in an illustrated pamphlet, "100 Years of British Glass Making, 1824–1924," which has recently been issued by the firm to commemorate its centenary celebrations.

THE building of the Literary and Scientific Institution of Bath was opened in January 1825. During the past hundred years much good work, especially in geology, has proceeded from Bath, as the names of William Smith, Lonsdale, Charles Moore, and H. H. Winwood bear witness; and the museum of the Institution houses many specimens of scientific importance, notably the fossils of the Charles Moore collection. Unfortunately the good people of Bath did not keep up their interest in the side of life represented by the Institution, and of late years, particularly during the War, the building was falling into decay, not without danger to its contents. Now there seems to be an intellectual and material revival. Repairs and rearrangements have been effected by the zeal and generosity of a few, and in one year 9000 visitors have passed through the pillared entrance. But more needs to be done if the Institution is to have a home worthy of its traditions and of its beautiful city. It is proposed to celebrate the centenary next January, and the most appropriate form of celebration will be a pecuniary contribution forwarded to the Secretary, Mr. P. E. Martineau. We cordially commend the appeal to our readers, who will be the more ready to help those who are helping themselves.

THE fourth Annual Report of the Forestry Commissioners for the year ending September 30, 1923, shows steady progress in afforestation. During the year, 10,463 acres were planted with about 18,000,000 trees, mostly conifers, the species used being Scots and Corsican pines, Norway and Sitka spruces, European

and Japanese larches, and Douglas fir. The cost of planting averaged 7*l.* per acre; and this figure included preparation of the ground, draining, fencing, actual planting, filling in blanks, and weeding. Except for seed, tools, and wire, the whole of this expenditure was on wages. The total land acquired during the four years amounts to 179,207 acres, of which 121,015 acres are classified as plantable, the remainder being either too poor or too good for timber production. In addition, eighteen Crown woods, formerly under the Commissioners of Woods and totalling 120,000 acres, were transferred in 1923 by Act of Parliament to the Forestry Commissioners. Two maps in the Report show the situation of all the areas now under the control of the latter. There are now two schools for the training of woodmen, one at Parkend in the Forest of Dean, and the other at Beaufort in Inverness-shire. Research and experimental work has made good progress. As many as 143 experimental plots, which are regularly thinned and measured, have been established in different parts of England and Scotland. A census of British woodlands is in course of preparation, and a summary of the completed statistics for twelve counties is given in the Report. The Forestry Commissioners were represented at the British Empire Forestry Conference, which was held in Canada during the summer of 1923; and a full account of the important resolutions passed by the Conference is appended to the Report.

"METEOROLOGY in Education" is the title of the reprint, now published, of the papers read on January 3 last at a conference of the Royal Meteorological Society, the Geographical Association, and the Science Masters' Association (Messrs. George Philip and Son, 1*s.* 6*d.* net). Sir Napier Shaw, who presided, introduced the subject as the study of weather as a scientific subject, and Mr. J Fairgrieve in the course of the discussion claimed that the conference was a successful attempt to get geography teachers and meteorologists to talk to each other. Mr. G. M. B. Dobson contributed a paper detailing recent results of research especially in regard to cyclonic and monsoon rains. Mr. L. B. Cundall in a paper dealing with school work in meteorology pleaded for the creation of a joint advisory committee of the three bodies to decide what should be taught in this connexion, and Mr. W. G. W. Mitchell directed attention to the use of wireless in relation to the compilation in schools of synoptic weather charts. During the discussion Sir Richard Gregory and Mr. W. E. Whitehouse both emphasised the position of the teacher of geography, for whom the results of meteorological science were merely initial data for use in the class-room. Dr. G. C. Simpson advised teachers to teach meteorology because it is a body of knowledge to which the pupil should be introduced. In any event the conference made quite clear that the current geographical teaching concerning rainfall distribution in relation to winds and pressure variation requires considerable emendation. Sir Napier Shaw stated that the wind distribution was only known for about three-fifths of the earth's surface.

THE library of the Chemical Society will be closed for stock-taking on August 4-August 16 inclusive, and will close each evening at 5 o'clock from August 18 until September 13.

DR. R. E. M. WHEELER, Keeper of the Department of Archæology in the National Museum of Wales and lecturer in archæology in the University College of South Wales and Monmouthshire at Cardiff, has been appointed Director of the National Museum of Wales, in succession to Dr. W. E. Hoyle, who has resigned owing to ill-health.

IN agreement with the programme of the International Commission for the Upper Air, the Meteorological Office of the Air Ministry sent up twelve registering balloons between March 3 and 22. The *Meteorological Magazine* for July states that of these, nine instruments have been found and returned. Eight ascents were made from the aerodrome at Shotwick, near Chester, and four from Kew Observatory, the losses being respectively 2 and 1. The greatest height reached was 19·3 km., 12 miles, the drifts being towards points between north-north-east and south-east. During five months working, 80 per cent. of the balloons sent up have been found and returned.

A DANISH ship, the *Godthaab*, started from Thorshavn at the end of June, according to the *Meteorological Magazine* for July, to visit settlements in north-east Greenland The vessel is to keep in communication with Jan Mayen by wireless telegraphy, and meteorological reports are being transmitted via Tromsoe. Reports from the *Godthaab* in the area off north-east Greenland in about latitude 75° N. have been received by the Forecast Division of the Meteorological Office, and they extend the information of the daily weather charts into the region of the Arctic north of the island of Jan Mayen and south-west of Spitsbergen, from both of which places daily reports are regularly received.

UNDER the auspices of the Royal Society for the Protection of Birds, a bird sanctuary has been established near Farnham, in Surrey, consisting of some twenty-seven acres of wild gorse, heather, and woodland, and well watered. This is eventually to become the property of the Royal Society for the Protection of Birds, so that it may be obtained in perpetuity as a wild nature reserve. A watcher who is well versed in wood-craft and bird-lore has been appointed, and an earnest appeal is made for the sum of 500*l.* to provide him with a cottage so that he can continually be on the estate. Donations will be gladly received by the hon. sec., R.S.P.B., 82 Victoria Street, London, S.W., or by Mrs. Minchin, Gorsedene, Farnham, Surrey.

THE marine biological laboratory at Wood's Hole in Massachusetts, founded in 1888 and for many years a centre of attraction to biologists of all parts of America, is to be developed on a great scale by means of a gift of 1,400,000 dollars from the Rockefeller Foundation, the Carnegie Corporation, and a fund endowed by Mr. C. R. Crane of Chicago. A combined laboratory and library building is to be

constructed at once at a cost of 600,000 dollars. At Wood's Hole, which has been called the summer capitol of American biology, zoologists, physiologists, embryologists and botanists gather every summer both for independent research and for theoretical and practical instruction courses. During 1923, seventy universities and research organisations contributed to the support of the laboratory.

By virtue of the Importation of Plumage (No. 2) Order, 1922, and (No. 1) Order, 1923, respectively, the names of the golden pheasant and of the *common or mute swan* were added to the Schedule to the Importation of Plumage Prohibition Act, 1921, which contains the names of certain birds whose plumage may be imported without licence. The Advisory Committee appointed under the Act has now recommended that the common or mute swan should be removed from the Schedule, but that the golden pheasant should remain thereon. The Board of Trade accordingly desires it to be known that an Order will be made in due course removing the name of the *common or mute swan* from the Schedule, with effect from October 1, 1924. On and after that date, the plumage of this bird will accordingly be prohibited from being imported except under Board of Trade licence issued in accordance with the provisions of the Act. The right to import the plumage of the golden pheasant without licence will continue as heretofore.

Dr. N. H. Darton, geologist, has left Washington to join the National Geographic Society's expedition, which is exploring an ancient temple in the Valley of Mexico, the oldest ruins so far discovered in the Americas. Dr. Darton will study especially the sequence of geological events, including the lava flows and the recession of Lake Texcoco, with the view of determining more nearly the exact period of the civilisation which flourished on the American continent some 7000 years ago. Mr. Byron Cummings, the head of the expedition, has already reported remarkable finds among the lava-encased temple mound—finds ranging from pottery, images, and sculpture to parts of human skeletons. It is believed the mound was built on or near the shore of Lake Texcoco originally, but the water line of the lake is now twelve miles distant. The lake had receded a considerable distance when a sudden volcanic eruption half buried the temple mound, which still was inhabited.

A conference on Illuminating Engineering has been arranged to take place at the British Empire Exhibition on Tuesday, August 12 (2.30-5.30 P.M.). The conference is timely in view of the two important conferences just held in Geneva, namely the first International Conference on Industrial Hygiene, and the meeting of the International Illumination Commission. In both cases important papers dealing with illumination were read, and special attention was devoted to the lighting of schools and factories. A report on the proceedings at these two congresses is to be presented, and other papers dealing with public lighting and other subjects will be read. It is also interesting to note that the opportunity will be taken at this conference to discuss the question of the lighting of exhibitions. Fuller particulars of the conference will be obtainable in due course from the hon. secretary of the Illuminating Engineering Society (Mr. L Gaster, 32 Victoria Street, London, S.W.1).

Our Astronomical Column.

Spiral and Structureless Nebulæ.—The *Observatory* for July contains a letter on this subject by Prof. C. D. Perrine. He criticises Prof. Lindemann's suggestion that the spirals are dust-clouds shining by reflection from the galaxy; he notes in opposition to this view that the Coal Sack and other very dark regions appear to be dust-clouds absorbing the light of the stars behind them; we should therefore expect them to shine by reflection much more brightly than the spirals since they are presumably much closer to the galactic stars; nevertheless they appear quite non-luminous both to the eye and photographic plate while the Andromeda nebula is very luminous. Further, he dwells on differences in the spectra of different spirals, some showing bright lines, others not; these would be difficult to understand if all of them shone by reflected galactic light.

Prof. Perrine considers that the structureless nebulæ are related to the spirals, being at an earlier stage of condensation, with less rapid rotation; both alike are supposed to consist of "cosmical matter." Possibly a considerable part of this may attain incandescence through collisions or electrical excitation, sufficient gas being evolved to account for the absorption spectra.

The variety of opinion that prevails about the nature of the spirals is evidence of the difficulty of the problems that they present. It is well to consider all reasonable suggestions, but not to expect a definite or final solution in the near future.

The Planet Uranus.—Mr. W. F Denning writes that Uranus will be favourably visible during the ensuing few months. The planet will rise on August 1 at 9 h. 6 m. P.M. and on August 31 at 7·6 P.M G.M.T. It will be in opposition to the sun on September 12 and will be perceptible during the whole night. Its position is in the southern portion of Pisces, and its present motion is retrograde amongst the small stars in that region. The planet's place may be found from an ephemeris and by the help of a catalogue of small stars. The intending observer should make a diagram containing the places of Uranus and of the stars in the same locality and then examine the sky with a suitable telescope and low power. In this way the planet may be easily identified; but should this method fail, the object may be known by its disc, which will be apparent with very moderate power and will contrast strongly with stellar images in the same field of view. The planet is distinctly visible to the unaided eye, being about $5\frac{1}{2}$ magnitude, and Mr. Denning considers, from many observations made at Bristol, that it might quite possibly have been discovered without telescopic aid, as it has been watched on many clear evenings near opposition in past years and changes distinctly noticed in its position. Uranus and the Moon will make some near approaches during ensuing months:

1924.	G.M.T. h	m.				
Aug. 16	9	16	Uranus	1°	44′	north of Moon.
Sept. 12	16	38	,,	1	37	,, ,,
Oct. 9	22	17	,,	1	34	,, ,,
Nov. 6	2	43	,,	1	42	,, ,,

Research Items.

WITCHCRAFT IN MEDIEVAL INDIA.—Mr W. Ivanow directs attention in the Journal of the Asiatic Society of Bengal, vol. xix., New Series, No. 3, to a "witch case" which affords a remarkably close parallel in its details to the practices of European witches. Hamid b. Fadli'l-lah Jamāli (a Sufi of Northern India) records about A.D. 1530, in a collection of stories of miraculous deeds, that when Shaykhu'l-Islām Farīdu'd-Dīn Mas'ud (d. A.D. 1265) was suffering from a serious indisposition, it was revealed to his son in a dream that he had been bewitched, but that the spell could be removed by the repetition of certain incantations over the tomb of a sorcerer, the father of the man responsible for the Shaykh's illness These instructions were followed, and in the course of repeating the incantations the son of the Shaykh accidentally discovered, hidden in the grave, a figure made of flour into which some needles were stuck, and on which were knotted hairs from a horse's tail. The figure was taken to the Shaykh, who ordered the needles to be drawn out, and the hairs to be unknotted. As this was done the pain diminished, and when all the needles had been withdrawn and all the hairs untied, it disappeared. The sorcerer was apprehended, but—and here the parallel with Europe ceases—was pardoned.

RACIAL INTRUSIONS IN ANCIENT EGYPT.—Sir Flinders Petrie in *Ancient Egypt* for June discusses the origin of the XIIth Dynasty in the light of the results obtained by the British School of Archæology in the excavations at Qau. Up to last season, it was known that there had been a Syrian occupation of Northern Egypt, a Libyan occupation of Middle Egypt, and, there was strong presumption, a Galla intrusion which could have originated this Dynasty. The examination of the tombs of the Uahka family at Qau last winter and a study of their names at different periods point to the existence of a principate holding Upper Egypt about the IXth and Xth Dynasties which brought in tombs of a hitherto unknown Nubian type. The measurements of the skulls indicate a close connexion between the Tigre skulls and Middle Dynastic Egyptian types, thus according with the Galla portrait in pointing to a southern origin. It would appear that when in the VIth Dynasty the Syrians took over the kingdom from the Egyptians, a king of the old style remained in the south, holding Nubia and Koptos. He was succeeded by invaders akin to the modern Gallas who held the Thebaid under the Libyan invaders and built the great temple-tombs of Qau. The Qau princes lasted through the Xth Dynasty, and finally one of them, aspiring to hold Thebes, took the name Amenemhat, and at the end of the Antef and Mentuhetep families occupied the throne and founded the line of the XIIth Dynasty, which, to the end, kept the features of its ancestry.

MOSQUITO CONTROL AT HAYLING ISLAND.—The third annual report of the Hayling Mosquito Control announces that satisfactory progress has been made in dealing with the local mosquito nuisance, although unavoidable delays have prevented the completion of the important experiments which had been undertaken on the range of flight of the salt-marsh species. The Control has, however, succeeded in obtaining the co-operation of a large number of persons by whose help it is hoped to make a detailed survey of the mosquitoes of south-east England. Such a survey should yield valuable results in elucidating the factors limiting the distribution of the various species as well as the individual range of flight. The year's work confirms the conclusion that the main pest in low-lying areas of the south coast is *Ochlerotatus detritus*. The present report is illustrated by some very fine photographs of this species, taken from a series of illustrations of the British mosquitoes which is being prepared by Mr. J. F. Marshall, the director of the Control, in his laboratory at "Seacourt," Hayling Island, Hants.

A NEW CRUSTACEAN.—The discovery of a representative of a new order in any group of animals is an event of interest to others besides the mere systematic specialist. This may perhaps prove to be the significance of the minute Crustacean which Th. Monod describes under the name of *Thermosbæna mirabilis* (Bull. Soc. Zool. France, xlix. No. 2, 1924, pp 58-68). It was found at El Hamma in Algeria in a Roman bath-cistern fed by a hot spring at a temperature of 48° C. The animal is about 3 mm. in length, colourless, and without any trace of eyes, its proper habitat being doubtless in the subterranean reservoirs from which the spring takes its origin. Its general appearance is that of a small Isopod, but the fore part of the body, as far as the fourth thoracic somite, is covered by a reduced carapace, the antennules are biramous, and the five pairs of walking legs (the last two pairs are suppressed) carry large exopodites Pleopods are absent except the first and second pairs, which are vestigial. The telson is coalesced with the last somite and the uropods are peculiar, with the inner branch much reduced. The mandibles are of the typical Peracaridan structure, and the other mouth-parts, although there are difficulties in their interpretation, are probably to be referred to the Mysidacean type. No breeding specimens were found, and it remains to be seen whether the individuals described had assumed fully adult characters and, in particular, whether the female possesses a brood-pouch of the characteristic Peracaridan structure In many of its features, Thermosbæna shows that simplification of structure which often goes with reduction in size and a subterranean habitat. When allowance is made for this, however, it seems to form a very satisfactory link between the Mysidacea and the Tanaidacea. There are few, if any, groups of arthropods in which it is possible, on morphological grounds alone, to construct so reasonably probable a phylogenetic series as that which leads from the Mysidacea through the Tanaidacea to the Isopoda. In this series there is a place ready for Thermosbæna, either as an outlying member of one of the existing orders or, more probably, as the solitary representative of a new order to be established for its reception when we have fuller knowledge of its structure.

AMŒBA FEEDING ON FRONTONIA.—C. Dale Beers (*Brit Journ. Exp. Biol.*, vol. 1, pp. 335-341, 1924) records observations on the feeding of *Amœba proteus* on the ciliate Frontonia. An Amœba was observed to have partially engulfed a Frontonia and by its pressure to have constricted the middle region of the ciliate until the latter was forced into the form of a dumb-bell, not by the pressure of two opposed pseudopodia, but by that exerted by a collar of the Amœba's protoplasm. One half of the Frontonia was enclosed by the Amœba, the other half was exposed, and by the beating of its cilia dragged the Amœba. Later the Amœba attached itself to the microscopic slide and proceeded with the ingestion, extending its protoplasmic collar while still maintaining the pressure exerted by it upon the narrow middle portion of the ciliate, so that this portion became continuously longer and finally gave way. The part of the ciliate within the Amœba was soon enclosed in a large food

vacuole—the whole process from beginning to end occupying eight minutes. Digestion of the engulfed part lasted nearly four days In another case observed, the Amœba carried out the same process, the pseudopodial collar being composed apparently only of ectosarc. The author points out that the observations do not accord with the view that the varied activities of Amœba are brought about entirely by changes in the surface tension of the protoplasm, it appears impossible to believe that surface tension could account for the compression of so turgid an organism as Frontonia, and for other features in the process of ingestion.

CULTURE OF AN ENDAMŒBA FROM THE TURTLE.—H. P. Barret and Nannie M. Smith (*Amer. Journ. Hygiene*, vol. iv., pp. 155-159, 1924) give an account of the cultivation of an Endamœba from the turtle *Chelydra serpentina*. The medium employed was human blood serum one part with nine parts of 0·5 per cent. salt solution. A portion of mucus containing the amœbæ from the intestine of the turtle was placed at the bottom of the culture tube in which the medium formed a column about 50 mm deep, and the tubes were kept at room temperature or in a cool chest (10°-15° C.). The presence of numerous bacteria or of blastocystis is inimical. The growth of the amœbæ takes place only at the bottom of the tube, never in the supernatant medium. On microscopic examination numerous dividing forms were observed, but no cysts were found even in old cultures. At the time of writing (October 1923) one strain was in its sixty-seventh subculture and had been carried on for 19 months, and two others had been grown 11 months and were each in the 36th subculture. It is pointed out that this material offers an easier problem than the human Endamœbæ as the lower temperature of the culture retards excessive bacterial growth. The authors remark that Cutler is the only recent worker who has succeeded in obtaining cultures of parasitic amœbæ, and though his work has been criticised by Dobell they "cannot fail to give credit to Cutler as being the first to grow parasitic amœbæ from the human intestine." In a paper which immediately follows, W. H. Taliaferro and F. O. Holmes describe specimens of the amœba—*Endamœba barreti*—from the turtle and from the cultures.

UTILISATION OF SEAWEED.—The Fuel Research Board of the Department of Scientific and Industrial Research has issued a Technical Paper (No. 9) dealing with the carbonisation of seaweed as a preliminary to the extraction of iodine and potassium salts. This industry has long been worked in the British Isles, and the weed has also been used as a manure. The old method of kelp-burning is very inefficient, and the work of Stanford, carried out in 1870–90, pointed the way to improved methods The paper describes further investigations along similar lines, and an endeavour has been made to provide data which will be useful in devising a method of carbonisation of the weed in which there would be no loss of iodine and in which the gaseous products could be used for firing the retorts A detailed description of the types of weed utilised, principally Laminaria, which contains about 0·5 per cent. of iodine, and of experiments on carbonisation, carried out on a small manufacturing scale, is given. During the nineteenth century the industry provided not a little employment, especially in the west of Scotland and in Ireland, and the report is worthy of attention

SCARCITY OF TERTIARY CRINOIDS.—In describing a new species of Balanocrinus from the Lower Miocene of Haiti (Proc. U.S. Nat. Mus., No. 2516), Dr. Frank Springer points out that this is the first stalked crinoid of Tertiary age to be described from the western hemisphere, and takes occasion to comment on the rarity of Tertiary crinoids in general. Although the number of crinoid species living to-day is probably as great as the number existing at any one time during the previous history of the earth, still the majority occur in relatively deep waters. Most Tertiary rocks are shallow-water deposits, and the inference is that crinoids assumed their present bathymetric distribution about the beginning of Tertiary time. It is also to be noted that most modern crinoids are of more delicate construction than their predecessors, and more likely to be broken up, especially in shallow water.

PHYSICAL CONSTITUTION OF THE EARTH.—In the *Annales de Physique*, May-June, Mr. Rokuro Yamamoto develops the mathematical theory of the passage of earthquake waves through the interior of the earth, and their refraction in passing through layers of different density. He shows that there is nothing which permits the conclusion that there is a sudden discontinuity in the density at a certain depth, such as was deduced by E. Wiechert in 1897, who assumed a central nucleus of iron, with a surface layer, $\frac{1}{5}r$ in thickness, of lower density. The mathematical treatment applied to the available observations shows that good agreement is obtained by assuming a gradual alteration of density with depth, and a calculation of the time of propagation of the Japanese earthquake of September 1923 to Paris, made on this basis, gives very good agreement with observation. M. Hamy and H. Poincaré showed in 1887 that the theory of density distribution then held was difficult to reconcile with the phenomena of precession and nutation, and A. Veronet in 1912 showed that a continuous variation in density accounts for astronomical and geological observations.

WEATHER AT SELSEY BILL—An analysis of the climate and weather at Selsey Bill, during the years 1908–23, has recently been issued by Mr. Edward Heron-Allen. The results for the sixteen years are given, not only as being of interest to residents but also as being acceptable to those who wish to know the climatic conditions afforded by the district. The extremely small mean range and variation of temperature, the well-graduated and distributed rainfall, and the great prevalence of sunshine, render Selsey an agreeable health resort. The mean temperature for the year is 50·5° F., the mean of the maximum readings is 56·7° and of the minimum 44·5°. In the eight years 1913–20, the shade temperature did not register 80°. The highest mean temperature for the year is 53·1° in 1921, the lowest 48·5° in 1909, omitting these two years of extreme temperature the range of annual means is 5·9°, from 52·8° in 1911 to 48·9° in 1917. The average annual rainfall is 29·24 in., the annual totals ranging from 38·21 in. in 1909 to 16·34 in. in 1921; the number of days with rain average 173, ranging from 194 in 1916 to 137 in 1911 and 1921. Sunshine is very prevalent, the average days for the year with bright sunshine being 310 and the average duration per day for the year 4·98 hours. A comparison with neighbouring health-resorts in the Book of Normals published by the Meteorological Office shows Selsey to have very favourable weather conditions.

NEW LINES IN THE SPECTRUM OF LITHIUM.—Observing the spectrum of the positive rays (canal rays) of lithium, M. M. Morand has discovered a number of new lines, which he ascribes to an unstable modification, ortholithium, the ordinary spectrum being due to stable paralithium (*Comptes rendus* of the Paris Academy of Sciences, June 2). The new lines are given in the following table:

Wave-length.	Intensity.		
3713	4	$1s$-$2p$	first of principal series.
4814	2	$2p$-$3s$	
4053	1	$2p$-$4s$	sharp series.
3756	0	$2p$-$5s$	
5488	3	$2p$-$3d$	
4244	2	$2p$-$4d$	
3841	1	$2p$-$5d$	diffuse series.
3653	0	$2p$-$6d$	

It is assumed that in the paralithium ion, the two electrons are in crossed 1_1 orbits, while in the ortholithium ion the orbits are coplanar, one being a 1_1 orbit while the principal quantum number of the other orbit is two. Details are given of the energy relations between the two modifications.

COEFFICIENT OF FRICTION FOR METALLIC SURFACES.—Experiments on the friction between different metals, in various states of polish, and without lubrication, are described by M. M. Fichter in the *Comptes rendus* of the Paris Academy of Sciences, June 2. The coefficient of friction was found to diminish up to a certain point, when the polish was improved; but increase of polish beyond this point increased the friction, so that for each pair of metals used, iron on iron, brass on brass, steel on brass, copper on zinc, there was a certain critical polish, with minimum friction. With brass-brass, for example, the coefficient of friction is lowered to about 0·12, and then increases rapidly; so that to separate the two blocks may require from 1·5 to 2 kg./cm.². To obtain plane polished surfaces, the blocks were rubbed together in water containing aluminium powder in suspension. The effect of heat and pressure on the perfectly polished blocks may produce actual union (welding), so perfect that it requires the ordinary breaking load to separate them. It is suggested that in ordinary friction, in addition to the effect due to the interlocking of the roughnesses of the two surfaces, a succession of partial welds must be produced, followed by the pulling away of elements of the surfaces which have been brought into intimate contact and welded. The tangential force of sliding friction would thus depend upon the elastic reactions of the welded parts, which are stretched to the breaking point, while new welds are produced at other points of the surface.

A NEW METHOD FOR PRODUCING SINGLE METALLIC CRYSTALS.—The method described by I. Obreimow and L. Schubnikow in the *Zeitschrift für Physik*, June 24, is a modification of that employed by Tammann, who poured melted bismuth into a small test tube, covered it with infusorial earth, and allowed it to cool slowly; when crystallisation started from a single centre, and the whole of the material was formed into a single crystal. Strelkow was able to extend the method to zinc, in which the number of crystallisation centres is larger, by introducing a small "bud" crystal at the top of a crucible full of fused zinc; the bud grew to fill the whole crucible when this was cooled from the top. The authors use a glass tube, drawn out to a capillary at the bottom, the metal is melted in the tube by means of a special electric furnace, which enables the temperature of the capillary to be controlled; the air is pumped out of the upper portion of the tube, and the capillary is cooled, an air blast being used for this purpose when necessary. If the capillary is small enough, section less than 1·5 sq mm. for zinc, 3 sq. cm. for antimony, a single bud crystal is formed in it, and grows when cooling is continued slowly at first, from the bottom to fill the whole tube. Rods from 2 to 10 mm. diameter and 30 cm. long have been obtained with tin, cadmium, zinc, antimony, aluminium, and magnesium. By varying the shape of the glass vessel, the form of the single crystal can be altered, and flat plates or cylindrical test pieces with thickenings at each end, for attachment to the testing machine, obtained.

NEW DEVICES FOR MICROSCOPES.—An exhibition of scientific instruments which is being given by Messrs. Ogilvy and Co. at 18 Bloomsbury Square, London, W.C.1, includes a large number of the most recent designs of Leitz microscopes and apparatus for photomicrographic and micro-projection work. A full range of microscopes for binocular vision suitable for all magnifications is shown. Prominent among these is the Ore Dressing Microscope, which is specially intended for the examination of granular products of concentration. The body is of the Greenough binocular type, but has several useful additions. Each tube is fitted with a revolving eye-piece holder carrying three eye-pieces which afford magnifications of 10, 15, and 20 respectively. Below the eye-piece a slot is provided for the insertion of a ruled glass plate, by means of which the number and size of the grains may be determined. The optical portion of the instrument may be moved in two directions at right angles to one another and to the central axis of the microscope, so as to cover an area of 5×5 cm. The grains to be examined are placed on a glass plate, also divided into squares, in a mount which fits the opening in the stage. Another noteworthy exhibit is the anti-vibration device with which the new Leitz photomicrographic camera is fitted. The optical bench, which carries the microscope, camera, and illuminating system, is mounted on springs which allow it to vibrate freely, the relative positions of the various components on the bench remaining quite undisturbed. The optical bench can be clamped to the table while the preliminary adjustments are being made, and many useful and novel devices are incorporated for simplifying these adjustments. The instruments and apparatus will remain on exhibit during the months of August and September, and may be examined by anyone interested. Demonstrations are given at 11 A.M. and 3 P.M. daily, except on Saturdays and Sundays.

FUSIBLE ALLOYS.—The name "fusible metal" is usually applied to alloys having melting points below that of tin. These are binary, ternary, and quaternary mixtures of lead, tin, bismuth, and cadmium. They are used mainly in the production of readily fusible safety plugs for automatic fire extinguisher systems, but during the War petrol tanks of complicated shape for aeroplane work were made by depositing copper on a casting of fusible metal, then melting out the latter in boiling water. In a paper in *Chemistry and Industry* for July 4, read before the Society of Chemical Industry, Dr. Budgen describes the properties of fusible alloys and communicates new experiments None of the twelve quaternary alloys was entirely liquid below 73°, nor was any entirely solid above 65·5°. The addition of 16·6 per cent. of mercury lowered these points to 63° and 50° respectively.

THE MELTING POINT OF GRAPHITE.—The *Chemiker Zeitung* of July 15 gives an abstract of a paper read at the Bunsen Gesellschaft at Göttingen in May on the melting point of graphite The experiments were made by Ryschkewitsch and consisted in passing a heavy current through a graphite rod with a constriction. At a certain temperature this constricted portion suddenly disappears, and kinematography shows that this is not due to a gradual evaporation. The temperature was also practically independent of pressure Calculation shows that the melting point of graphite is about 3800° abs.

Pre-Columbian Representations of the Elephant in America.

By Dr. HENRY O. FORBES.

IN NATURE of November 25, December 16, 1915, and January 27, 1916, Prof. Elliot Smith set forth very circumstantially his reasons for supporting Von Humboldt in interpreting certain features of a Stela (known as B) from Copan in Central America, as a pre-Columbian representation of an elephant's trunk. This view was combated vigorously in NATURE of January 27 by three well-known American archæologists, Dr. Spinden, Prof. Allen, and Dr Stozzer. Elliot Smith and his school attach the greatest importance to the correctness of the elephant-trunk interpretation, since it forms one of the crucial facts on which they rest their doctrine of the transference of civilisation from the Old—especially from Egypt and India—to the New World. According to Elliot Smith, the deity, spoken of as the "long-nosed god," "who was most often depicted upon the Ancient Maya and Aztec codices was the Indian rain-god Indra, who in America was provided with the head of the Indian Elephant," seemingly "in confusion with the Indian Ganesa."

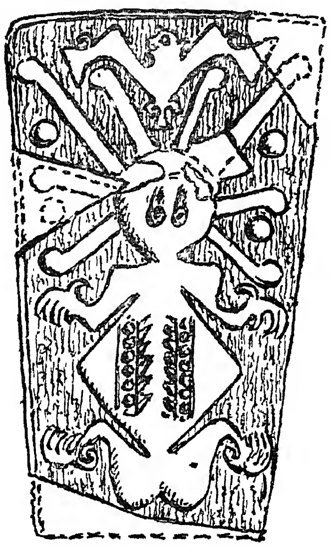


FIG. 1.—Manabi slab. (After Saville.)

I do not claim to have made a special study of Central American archæology, but I took the deepest interest in that of Peru during my sojourn there, and I have since followed with close attention any evidence tending to indicate culture-transfer between the two worlds.

The statements of Elliot Smith seemed on their appearance by their emphatically assured tone, supported by a drawing he gives of part of the Stela, apparently to afford evidence of a contact between East and West. Yet among many anthropologists, both in England and America, grave doubts have been expressed as to his interpretation of this feature of the monolith, owing to the extreme improbability of a totally alien mythology modifying successfully a very highly specialised and altogether different one, "including practically" (as Elliot Smith asserts) "the whole of the beliefs associated with" and the acceptance of "the worship of Indra."

During a tardy convalescence I have devoted some time to a careful study of the literature bearing on this point and of Dr. Maudsley's magnificent illustrations of the Copan monuments, without which it is impossible to form an opinion upon or criticise Elliot Smith's drawing in NATURE, November 25, 1915. The result is that I have arrived at an interpretation of the "elephant-trunk," different from his, which I submit to the consideration of archæologists. The *motif* of the deity's long nose is certainly not an Indian or other elephant's trunk, nor entirely, though perhaps partly, a macaw's beak, nor probably a tapir's snout; but I suggest with some confidence it is a feature derived from one or other of the Cephalopoda—squid, loligo, argonaut, octopus, or a combination of them. This suggestion, if accepted, will, I believe, help to elucidate much of the complicated emblems in which so many Central American sculptures abound.

The cephalopodous genera I have mentioned are all denizens of the eastern or western coasts of America, and any one of them might suitably be adopted as a motive in Maya mythology. Indeed an engraved stone slab from Manabi Island (Fig. 1), off the coast of Ecuador, shows that the squid (although here provided with spurious limbs) clearly entered into the mythology of that country, if not also into that of one or more regions of South America; for I found numerous cephalopod eyes and prehensile suckers from some specially large species in many of the pre-Inca graves I excavated in Peru. On the other hand, the elephant is entirely alien to America. No nation suddenly changes its mental orientation. "Mere similarity of ornament," as Mr. Joyce very truly remarks, "means nothing when the ornamentation in question is found to symbolise beliefs of an entirely different character."

It is perhaps desirable to recall the following characters in the cephalopods for purposes of the comparisons I have instituted: their long tapering serpentiform arms provided with rows of prehensile suckers; their very strong mandibles, so remarkably similar to a macaw's beak, conspicuous in the centre of their surrounding arms; their water-discharging funnel—often absurdly nose-like—opening on the mollusc's (frequently warty) body (or mantle) or between its arms; their immense round, staring, black, crescent-pupilled eyes, calculated to fascinate the superstitious and the timid. Some of the species inhabiting the west coast of America possess arms a score of feet in length and mandibles far larger than any macaw's—formidable and terrorising animals if unexpectedly encountered. Members of the ten-armed section of the group have two tentacles longer than the others, terminating in an expanded club arrayed with four rows of suckers.

My interpretation of the Stela will be more easily followed if I first direct attention to a lintel representing the "serpent-bird" from Tikal, well pictured as Fig. 17, p. 55, of Mr. Joyce's excellent "Guide to the Maudsley Collection of Maya Sculptures in the British Museum." This lintel (Fig. 2), according to Prof. Elliot Smith, reproduces "a highly Americanised representation of the 'winged disc and serpents' [seen over the doors of Egyptian temples]." Here "the god's face now replaces the disc as in some of the Asiatic derivatives of the Egyptian design. . . . A striking confirmation of this interpretation (*i.e.* the conventionalisation of the serpent's 'body' into a simple cross) is supplied by Maudsley, who has shown that the pattern below the cross" (which I have

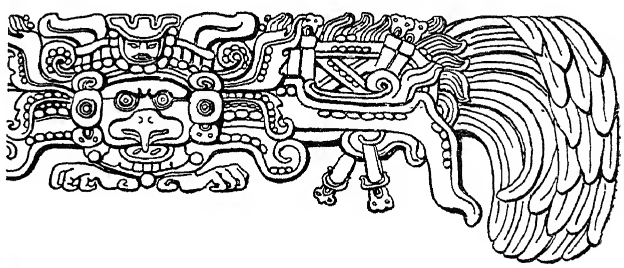


FIG. 2.—Serpent-bird, from Tikal (After Maudsley and Joyce)

identified as the snake's body) " is really a very highly conventionalised serpent's head reversed." It is with great diffidence that I venture to differ from so distinguished an authority on Central American archæology as Dr. Maudsley. If, however, he and other interested archæologists will follow the interpretation I submit here, I hope it may prove as convincing to them as to myself.

The interpretation which I would submit is: The Tikal lintel represents, in its central part, neither more nor less than a slightly specialised argonaut or octopus, with its beak displayed in the centre of its radiating tentacular arms, representing the " god's face." Over it two round eyes glare out under a strongly marked corrugated " superciliary ridge." This ridge is the fleshy upper margin of the mollusc's mouth, which continues into its under-margin, formed by a fleshy band, seen resting upon two avian tarsi and toes. This lower fleshy oral border, marked by three circular pedunculated discs representing contracted tentacles on the margin of the mouth, gives origin, right and left, to a clearly defined tentacle, on which are depicted the prehensile suckers of the mollusc in the form of raised circular knobs, and terminating in a hook-like tip. On right and left the oral marginal angles are largely concealed by what may be termed " ear " ornaments (with their pendants), from behind which issues, on each side, a long massive arm, extending horizontally in somewhat angular undulations until it reaches the commencement of the conspicuous feathered extremities of the lintel, where it bends downward and outward, and ends in a hook-like tip (as in the long arm of Rossia). Along its length is sculptured an interrupted series of round elevated discs, representing prehensile tentacular suckers.

Starting from the same point (but in front of this larger tentacle) there can be identified another arm, coiling downwards, with a serrated margin towards its termination, and displaying the usual suckers, coiled end, and characteristic hook-like tip. Immediately above the " ear " ornament a very short, closely coiled-up, contracted arm takes origin from the margin of the mouth, while a stage higher on the lintel is seen stretching upward a very prominent arm serrated on its under margin (as in some living species), broadening towards its free end, and exhibiting conspicuously the usual suckers. This tentacle arises on each side out of the black-edged upper oral margin of the mollusc above the eyes, while from behind it arises yet another, easily traced by its suckers. This latter extends horizontally in the background (having attached to it the wing-coverts and quills of the feathered extremities of the panel) as far outwards as the curious mace-like objects (seen at the inner edge of the feathered area), where it descends in a wide sweep in rear of the longest horizontal arm, to terminate in a scroll which appears below its lower border in a double-hooked tip. Above the flat-ended arm still another, short and closely coiled, takes rise. Its prehensile suckers begin, in a row of circular knobs, beneath the centre of the " chin " of the small central face, on the upper edge of the lintel, and continue onwards (beneath a space-filling detail) along the coil of the tentacle. Finally, behind this detail on each side arises an arm more robust, stumpy, and even " elephant-trunk "-like than the others, the prehensile suckers of which follow along both " cheeks " of the small " face." In all, seven pairs of tentacular arms surround the parrot-mandibled mouth of this design. The digits of the avian foot beneath the lower oral boundary belong to the bird the feathers of which form the terminal ornaments of the lintel. One can easily imagine that the Maya artist, finding a marine creature with a beak so macaw-like, would feel impelled to add some avian concomitants to his sculpture. He obviously took as his model for them the bird on the relief in the Palenque Temple of the Foliated Cross (Joyce's Guide, Fig. 13).

The lintel, therefore, if these interpretations be accepted, represents not " a serpent's head reversed," but an octopus with its beak displayed, as in Nature, amid its tentacular arms, and should be designated rather a feathered octopus than a " feathered snake." In any case, this sculptured design presents in no detail the remotest suggestion of an elephant or, to my vision, of a serpent, nor does it owe any inspiration to Egypt, India, or Asia; it is purely of Maya origin.

If, bearing in mind the interpretation above suggested of " the arms," " tentacular discs," and " body outline " in the " feathered snake," a close examination be made of Plate V. of Mr. Joyce's Guide where the head of the Death-god is pictured, I venture to think a strong confirmation of a cephalopod being a Maya motive will be admitted, for upon it (Fig. 3)

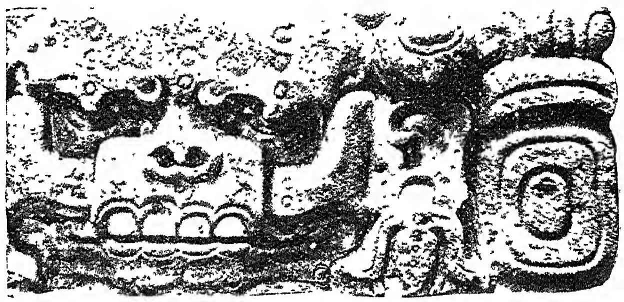


FIG. 3.—Head of Death-god, face of altar-table, Copan. (After Maudsley and Joyce)

two squids quite unspecialised are clearly sculptured. The " face of the god " anthropomorphised in having human teeth conspicuously exposed by the absence of fleshy lips, takes the place of the parrot-beak of the mollusc, and is completed by a nose with two nostrils—probably derived from the sepuncle of the cephalopod, the function of which would be unintelligible to the artist. Deep set beneath a strong " superciliary ridge " are two organs, which *seem* to be eyes. Yet they more probably represent the large tentacular suckers of the two massive fleshy arms curving up under them, recalling the stumpy tentacles of the Tikal lintel. I lean to the second alternative. If this be so, then the two prominent organs at the upper edge of the altar-face are to be identified as the god's eyes. The " superciliary ridge " forms the margin, fringed with short retracted tentacles, of the monster's body (the continuation of which probably extended over the altar-table), as well as the upper margin of its mouth. Of these small fringe tentacles, one is seen on each side of the " nose." The sulcus between them corresponds with a corrugation observable between the eyes of the " feathered serpent," and helps to support my suggestion that the dark line on that panel also indicates the upper edge of a cephalopod's mouth. Similar circular tubercles, on what are plainly the mollusc's mantle, occur also on the body of the squid carved on the Manabi slab (Fig. 1) already referred to, where there is no question as to its zoological identity. Close examination of the panel reveals on the extreme right of the " superciliary fringe " the trend of the edge (indistinct on the left side) of the oral orifice which, passing behind the robust arm, reappears below as the lower margin of the mouth—scalloped (by retracted tentacles) and " warted " as on the

higher part of the mantle—passing underneath what may be called mandibular teeth, then continuing upward to meet the mantle on the left side and complete its oral boundaries. It will be noted that the Maya conventionalism for representing the dermal surface of cephalopods is by circular tubercles. These are observable here on the surface of the body, on the notch of the " nose," on the " lip " between the

FIG. 4.—Stela B. Front. (From Maudsley's photograph.)

" nose " and the upper teeth, on the two robust tentacles, and on the lower oral margin. In the argonaut, the two central arms, when all are spread, are often so closely apposed as to appear a single very broad tentacle—a feature very conspicuous in the South Atlantic Bathypolypus.

My interpretation, therefore, of the morphology of this panel is that the whole of what forms here the " face " is delineated upon a much broadened tentacle, emanating centrally from the mollusc's body, so as to overhang and conceal its true mouth, where would naturally be seen its parrot-like mandibles, as in the " feathered serpent." The space to right and left of this broad, face-fashioned tentacle, is filled in by an unmistakable species of squid, the lower end of which rests on the base of the panel, while its oral end gives rise to a circle of prehensile tentacles, two coiling downwards and more than one upwards, while the central line of its mantle is marked by a row of circular warts, as on the Manabi slab (Fig. 1). A tentacle marked with suckers is coiled round each end of the bar over which the cephalopod is apparently holding on, disjoined possibly from its continuation on the altar-table. The right and left extremities of the panel are ornamented by an oblong detail, which I should not hesitate to determine—if asked to do so—as the eye of a large species of Ommatostrophes.

This altar-face panel, I argue, supplies the key to the intricate and foliated ornament in many Maya sculptures, in that the details are traceable to cephalopods of perhaps more than one species—indigenous emblems at all events, in which there is not the slightest suggestion of anything proboscidean.

Coming now to the Stela B, " famous for the realistic representation of the Indian elephant at Copan " (of which Prof. Elliot Smith, in his " Evolution of the Dragon," has reproduced a *front* view Fig. 19 from Dr. Maudsley's plate 36, in the volume on archæology in Godman's " Biologia Centrali-Americana "), we may compare the intricate details of the monolith with those in the two panels discussed above. If, however, the right and left front *edges* of the Stela had been figured, a full view of both "trunks" and other important details, not visible *en face*, could have been more instructively studied. Dr. Maudsley's photograph (in the " Biologia ") is accompanied by an elucidatory diagram to render the intricate decoration of the stone more easily followed. This diagram does not, however, quite faithfully reproduce the sculpture, and as its upper portion has been used by Elliot Smith to illustrate his letter in NATURE of November 15, 1915, it is very misleading, as will presently be noted.

The feature, on both " trunks " (Fig. 4), interpreted as a nostril, due to the ignorance (?) of the Maya artist, is clearly in its shape and more or less accurately as to its position a cephalopodous eye, like that of Sepiola, situated, as it should be, on the animal's body or mantle. Turning attention now to the right-hand upper corner of the statue, we discover there Elliot Smith's " auditory meatus." On the left of the " trunk " is (as the photograph, Fig. 5, sufficiently testifies) a tentacular arm issuing from a fold of the mollusc's body (the " forehead " of the elephant) and so coiled up as in Rossia that it ends in a close circular spiral, armed throughout its length with its rows of prehensile suckers. On the right of the trunk the origin of this coiled-up tentacle (" auditory meatus ") is concealed by a flamboyant bouquet of tentacles, the suckers of which are nevertheless to be seen between and behind the flambeau. This " scroll below the ear as well as the tree-like appendages above the head," are in Elliot Smith's view " parts of the conventional waves breaking around the *sea-type* of Indian Makara." Yet the elephant of the Stela is a mahout-riding species ! I feel convinced, nevertheless, that the " ear-pinnæ " of Elliot Smith (arising from behind the bar-like detail on which are seated the two human figures visible on the front aspect of the monolith) are undoubtedly cephalopod arms recalling those of Cledone. They coil round beneath the " meatus " tentacle, and end in a sharp thorn-like tip (as in Rossia) projecting conspicuously from the plane of the Stela—surely an unusual appendage to an ear-flap. These tentacles, as drawn in the

FIG. 5.—Stela B. Right-hand edge. (From Maudsley's photograph.)

elucidatory diagram, unfortunately show none of the suckers definitive of their function, though they are clearly represented in the photograph. Above both these details another (rather damaged) tentacle can be traced at the summit of the monolith on each side, coiling upwards and inwards from a fold of the mollusc's body (the " elephant's " head)—none of them analogous to any organ in a proboscidean.

Studying now the corresponding angle on the left side of the monolith (Fig. 6) we see a bodyless turbaned head poised on the mollusc's body (the " elephant's " neck). This is interpreted by Elliot Smith as a mahout. On the elucidatory diagram are delineated

this driver with his braceleted hand and bent arm resting on the "elephant's forehead," and also the edge of his so-called "driving-stick" and the tips of his fingers. The Stela, however, shows absolutely no such features. Were the arm correctly drawn in the diagram, it must originate from the driver's ear, for he has no fragment of a shoulder, no body, no arms or hands—a head only—the braceleted wrist and arm are imaginary. Underneath the "mahout's" chin originates (as on the corresponding dextral aspect) a tentacle as a closely coiled spiral (again the "auditory meatus") with its prehensile suckers. More to the left the mollusc's body gives off a second tentacle, which meets a third, coiled up reversely, all of them armed with prehensile suckers. The ridge seen in the front view, under wh ch the bent arm of the rider is drawn in the diagram, is clearly the fleshy edge of the mollusc's body, corresponding to that on the right side of the "trunk" on the right corner. From the body of the cephalopod, just beneath the "rider's" chin and above the eye which is overshadowed by it, there clearly originates from the mollusc's body a more slender tentacle, overlaid upon the "trunk," the function of which is denoted by its prehensile suckers. How erroneously this detail has been interpreted as a mahout's driving-stick—which he has no arm or hand to hold—an inspection of the photograph of the Stela itself, our sole witness, proves. The right-hand "trunk" carries no mahout and shows no "driving-stick."

Fig 6—Stela B. Left-hand edge (From Maudsley's photograph.)

Both the "trunks"—neither of which, by the way, is accompanied by tusks although Elliot Smith refers to such a feature—are, therefore, but very large robust tentacles (one enlarged tentacular arm is not an unfamiliar character in living cephalopods) the suckers of which are indicated by the cross-hatching instead of by the usual circular tuberculations, confusing perhaps macaw with cephalopod emblems. The mollusc's body, therefore, gives off around the "trunk" and "head" quite an array of tentacular arms which cannot be associated with anything in proboscidean anatomy. The supposed mahout is not the only human figure on the Stela Two are seen in the front view, sitting between the two "trunks"; while down both its front edges, below the level of the "trunks," is sculptured a series of figures, or only heads, all of them on the Stela itself, turbaned as in the Rain-god, but none of them showing any proboscidean relationships. They have neither "trunks" to sit on nor "sticks" to drive with. If they are not mahouts, neither may the uppermost figure (seated on the mollusc's mantle) be so interpreted. As this supposed "driving-stick" turns out to be a cephalopodous tentacle, *cadit quæstio*, both as regards the trunk and the mahout.

Moreover, the turban of the "Rain-god" presents a most suggestive and interpretative "ornament." This symbol—if the two panels already discussed be kept in mind, especially that representing the Death-god—clearly represents a cephalopodous animal. On each side (the right broken) of the turban (Fig. 4) there hangs down an octopod (?) tentacle, with its free tip exactly recalling that of the longer arm in the "feathered snake" and of Argonauta or Rossia, both showing the usual circular tuberculations representing prehensile suckers. On the top of the turban and on each side a second suckered tentacle is coiled, while rising perpendicularly from the centre of its crown is seen what is quite easily resolvable into two tentacles, armed with suckers, closely applied edge to edge, as in the argonaut, but diverging half-way up to embrace a "cartouche" enclosing emblems quite in keeping with the motive—three prominent suckers, then still ascending to end in a lingulate finial.

That the cephalopod motive is a real one in South American mythology is evident from the Death-god panel and the Menabi slab; but further confirmation comes from the presence of at least one unmistakable cephalopod in the centre of the beautifully decorated reverse of the monolith (Fig. 7), where it gives off two downward coiled tentacles and two long upwardly directed arms with their characteristic terminal hook and prehensile discs. Cephalopodous emblems run riot indeed over the statue on all its sides, while not a single detail (except the mistakenly named "trunks") recalls anything in the anatomy or life of an elephant of any species, or of any creature alien to America.

It is possible, from my point of view, to interpret in the same sense the emblematic decoration in more than one of the Copan mythological designs—to name only two: the left upper vignette on the Dresden Maya Codex (Fig. 11, Joyce's Guide); and especially the left glyph in the upper row of his Fig. 6 of "Full-figure Numerals." I may add also the glyph figured by Dr. Spinden, Fig. 1, *c* in Nature of January 27, 1916, which is combined with the macaw motive.

In his letters to Nature referred to above, Prof. Elliot Smith avers that the scroll (representing the pinna) "was an essential part of the elephant design before it left Asia"; that "the sculptor was not familiar with the actual animal"; that he "has mistaken the eye for the nostril and the auditory meatus for the eye"; has represented "the ventral surface of the trunk in a conventionalised manner without any adequate realisation of the true nature of the features he was modelling"; and that "having converted the auditory meatus into an eye he converted the pinna into a geometrical pattern" which "he was careful to restrict to the area occupied by a relatively small pinna that is distinctive of the Indian species." Yet, notwithstanding these many defaults of memory which are charged to the Maya sculptor,

Fig. 7.—Stela B Part of the reverse of the monolith. (From Maudsley's photograph)

one cannot fail to marvel that he could draw the outline of the head so accurately as to enable a zoologist to identify the original model as the Indian species and to distribute its various errors with so much acumen.

Elliot Smith's ardent supporter, Mr. Perry, provides us with a fact that increases still more our amazement: the "movement of culture," he tells us, "that set out from Egypt" [always as stressed by Rivers without their women folk] "about the beginning of the fourth millennium B.C., ultimately landed in America [after centuries spent in India, Indonesia, and Polynesia] about the beginning of our era and there founded civilisations essentially the same as that of Egypt in the Pyramid Age. . . . This movement took 3000 years, more or less, to accomplish the journey, but it can be traced with fair accuracy for thousands of miles." It is therefore scarcely surprising not only that the god Indra was confused with Ganesa and that certain features—nose, ear, pinna, turbaned rider—of the elephant head during that period became but a memory to the bearers of the heliolithic civilisation to America, but that any resemblance even of the outline of its (tuskless) head and the appropriateness of a "driver" were so well conserved, especially as Elliot Smith assures us that the motive on the Stela was not the land elephant but "the sea-elephant design of the mythical Makara [a snouted monster with large prominent tusks and a fish's tail, which never existed on land or sea, and never carried a mahout] which was the commonest form of elephant spread abroad by the sea-men of Southern India copied from an earlier model (or *picture*, according to Elliot Smith) [made thousands of years before] by some immigrant from Asia." Imagine a picture—on what material soever depicted—surviving all these millenniums among a people who were only "food-gatherers" in the palæolithic stage when the heliolithic missionaries arrived among them!

Which is more likely to have inspired the Maya sculptor, a mythical animal, the memory of which 3000 years must have paled to obliteration, the outlines, moreover, of which had never been seen by any human eye; or creatures familiar to him in his own seas, which must have excited his dread, and aroused his artistic sense?

I have to acknowledge Dr. Maudsley's photographs in the "Biologia" as the source of the above figures, and his kindness in permitting me to use them, and to thank Mr. J. Edge-Partington for sketching Fig. 1 for me.

The British Medical Association at Bradford.

TISSUE CULTURE.

AT the ninety-second annual meeting of the British Medical Association held at Bradford on July 22-25, Dr. Alexis Carrel, of the Rockefeller Institute, New York, opened a discussion on the method of tissue culture and its bearing on pathological problems. The present position of tissue culture *in vitro* was clearly summarised, and considerable space was devoted to the most recent view of American workers that there are growth-promoting substances—trephones—which are secreted by certain cells of the body to minister to the nutritive wants of other cells. It is believed that leucocytic trephones play an important part in physiological and pathological processes. They secrete substances, *in vitro* and *in vivo*, and enable fibroblasts to grow readily.

IMMUNITY.

At the same meeting, Dr. R. A. O'Brien, of the Wellcome Physiological Research Laboratories, opened a discussion on immunity, with special reference to specificity and the influence of non-specific factors. It is now a hundred years since the great French clinician Bretonneau, from a mass of observations, set free the doctrine of specificity in disease. His particular contributions referred to enteric fever and diphtheria. After long years of confusion, Dr. William Budd, in the 'sixties of last century, again placed the doctrine of specificity on a sound basis, both with respect to enteric fever and to tuberculosis. The exact experiments of Robert Koch from 1876 onwards established the specificity doctrine on an irrefutable basis, which was again extended through the discovery of antitoxin by Behring and Kitasato in 1890. Since that time every well-authenticated observation on man or animals has confirmed the specificity of infective virus

It has been claimed, however, that certain substances which are non-specific in the sense that they have no direct or immediate affinity with the specific causes of disease may act in a curative manner. It is the published data on this point which Dr. O'Brien has analysed. In certain instances he has subjected the question to experimental inquiry, and has been unable to find evidence that non-specific substances influence favourably specific experimental infections or intoxications. Against this is a slowly growing mass of clinical observation, which seems to point to therapeutic successes in a variety of diseases. Protein substances such as occur in milk, blood serum, and egg are claimed to be endowed with curative properties believed to be great or even extraordinary. We have recently been asked to believe that injections of milk will cure duodenal ulcers.

Many clinical observations are without much value on account of their uncritical character and the complexity of the factors involved. This non-specific therapy may be a fashion in therapeutics. At all periods there have been many such. It is said that a new drug should be exhibited while it *still* cures. It is also well not to forget that medicine still retains many of the characteristics which it had nineteen hundred years ago, when Celsus wrote, "Medicine is a conjectural art, and the nature of conjecture is such that although it answers for the most part, yet sometimes it fails."

THE MICROSCOPY OF THE LIVING EYE.

When von Graefe first saw the fundus of the living eye with Helmholtz's ophthalmoscope in 1858, he is said to have exclaimed, "Helmholtz has unfolded to us a new world! What remains to be discovered!" Indeed it is questionable whether any single physical invention has been a greater boon to medical science than the ophthalmoscope. The latest development of ophthalmoscopy is the microscopy of the living eye, the technique of which has been elaborated by several ophthalmologists, but chiefly by the celebrated Allvar Gullstrand of Uppsala. Briefly stated, the method consists of illuminating the living eye by a narrow beam of light furnished by a nitra slit-lamp and condenser, and with diaphragms of various small apertures. The details of the structures so illuminated are observed obliquely, either by the "teleloup" or Czapski's binocular microscope. The teleloup consists of a pair of miniature opera-glasses fixed on a spectacle frame. It gives a stereoscopic image with a magnification of about two diameters. With the microscope, nine diameters or more of magnification can be obtained.

The practical value of this new method of micro-ophthalmoscopy formed the subject of an interesting discussion in the Ophthalmological Section, from which it is obvious that it has already yielded results of considerable scientific and practical interest. In opening the discussion, Mr. Basil Graves dealt with the physiological aspect of these results. He showed that it was possible by delicate adjustment of the illumination to demonstrate that the aqueous humour, the most pellucid of the body fluids, is not absolutely transparent, but that the range of what might be regarded as normal relucency could be determined. He has also detected varying degrees of metallic lustre in the crystalline lens, which he attributes to internal reflection from the lamellar surfaces in the interior of the lens itself.

Dr. Harrison Butler's *résumé* of the diagnostic aids which the new technique has already yielded in his hands affords an ample justification for its introduction into the practice of ophthalmology, and gives promise of further useful developments. The exact depth to which ulcerations have extended, and the localisation and extent of inflammatory processes in the cornea, can be determined with accuracy. The various forms of cataract can be detected in their earliest stages, and differentiated from one another with greater precision than heretofore. As the subsequent course and the treatment required for these several forms of cataract are widely different, it is, of course, important to be able to distinguish them early and surely. Another highly important application is in the early diagnosis of the much-dreaded sympathetic ophthalmia, by which disease many perfectly sound eyes are lost as the result of septic infection of the opposite eye. If the diagnosis is made sufficiently early, the good eye can be saved by prompt removal of the damaged eye. The detection of slight increase of turbidity of, or minute floating particles in, the fluid in the anterior chamber is the danger signal in this condition. Most of the points touched upon by the openers of the discussion are much better appreciated by demonstration than by description, consequently the interest of the meeting was focussed largely on the drawings and figures by which the papers were illustrated.

Edinburgh Conference on the Vegetative Propagation of Plants.

TO botanists and horticulturists all over the world the fame of the Botanic Garden at Edinburgh requires little comment. The collection of trees and shrubs is one of its many features; its Rock Garden alone has made it famous. So remarkable is the collection that a leading botanist from abroad was struck, not by the vast number of interesting plants, but by the fact that there are so few uninteresting ones. But the plants which meet the eye of the visitor are largely the production of that deft manipulation in the propagating pits screened from the general view, where much patient work is apt to be overlooked. Only those who have had the experience know the difficulties which so often beset the gardener who has to deal with the growing of a large representation of the world flora.

To make more generally known some of the experiences gained in the Royal Garden at Edinburgh, a well-attended Conference on the Vegetative Propagation of Plants was held on July 17 and 18 under the auspices of the Botanical Society of Edinburgh. By permission of Prof. W. Wright Smith, Regius Keeper, the meeting was conducted at the Garden, and in the large laboratory attached thereto there was on exhibition about 300 species of seed-plants, supplemented by nearly 200 photographs, illustrating various methods of propagation from stem, root, and leaf as practised by Mr. L. B. Stewart, who is in charge of the Department of Propagation. Some of the results obtained in actual practice are remarkable enough in themselves, but an added interest lies in the wide field for anatomical and physiological investigation which they throw open. It is fortunate that close co-operation exists between the Garden and the University Department of Botany, and numerous problems arising out of the experience of the cultivator are under investigation at the hands of the botanist.

Certain specific questions have already received attention and these were brought before the Conference. Thus, in the genus Clematis, it is found that stem-cuttings root freely when the cutting is made through an internode but usually not at all if cut at the node. Miss Edith Philip Smith dealt with this problem and showed that the peculiarity may be related to the large amount of sclerenchymatous tissue occurring at the nodes, since it is found that if stems are etiolated before the cuttings are prepared, rooting from the node takes place readily. Etiolation is considered to act in two ways, resulting in a softening of the mechanical tissues of the stem and in a restoration of the carbon-nitrogen ratio which is regarded as necessary for establishing meristematic activity.

Mr. L. B. Stewart dealt with the propagation of plants possessing horizontal branches, taking Napoleona and Gardenia as special cases. In the former, a non-orthotropic branch-cutting gives rise to a new individual which fails to establish a vertical shoot axis In the course of time, however, an adventitious bud may develop from the root system to produce an ordinary orthotropic stem. In Gardenia, a cutting prepared from a horizontal branch leads to the establishment of a new plant quite distinct in growth-form from the parent. No leading shoot is formed and horizontal branching does not occur; moreover, the new individual is precocious in flowering. Mr. Stewart discussed also the results of propagation from roots, dealing especially with Pelargonium and *Acanthus montanus*. In the latter, the form of plants raised from root-cuttings is juvenile or adult according to whether young or old portions of the root are used.

Propagation by means of leaves formed the subject of a communication by Dr. R. J. D. Graham. In leaf-cuttings of dicotyledons which do not possess succulent leaves the root system is first established, followed by the development of the shoot. The time of appearance of the shoot seems to depend to some extent on the viability of the leaf. In monocotyledons, however, shoot buds appear before the formation of roots, and succulent leaves of dicotyledons behave in the same way.

Dr. Graham gave an account also of the propagation of bulbous plants by making use of the bulb scales. In Ornithogalum, Drimia, and Hæmanthus, isolated bulb scales are exposed to sunlight to allow the mucilage of the injured surface to dry. The leaf bases are then laid on sand, watered once in ten days, and within four weeks numerous bulbils begin to develop on the adaxial side of the scales. This provides a quick method of obtaining large supplies of saleable bulbs. The induced buds arise in Ornithogalum from meristematic tissue near the leaf base. In Drimia, bud formation may be induced either in the parenchyma cells of the scale or in the callus formed on the injured surface. In Hæmanthus, buds arise from the hypodermal layers of the detached leaf base.

University and Educational Intelligence.

CAMBRIDGE.—Dr. G. H. F. Nuttall, Magdalene College, has been re-elected into the Quick professorship of biology. D. L. Burn, Christ's College, has been elected Wrenbury scholar in economics.

As indicative of the growing place that organised research is holding in the University, a list of studentships awarded by the various colleges at the end of the past academic year may be of interest. At Peterhouse, W. A. Wooster (physics) and W. G. East (history); at Christ's College, A. L. Peck (classics) and D. L. Burn (history); at Magdalene College, G. E. Watts (chemistry); at St. John's College, W. H. Dew (chemistry), T. G. Room (mathematics), G. R. Potter (history), L. H. Titterton (Oriental languages), J. D. Cockcroft (mathematics), T. A. A. Broadbent (mathematics), and F. H. Constable (chemistry); at Pembroke College, H. G. Handisyde (history) and W. J. V. Ward (chemistry); at Gonville and Caius College, A. B. C. Cobban (history), R. Raper (chemistry), I. F. D. Morrow (history), W. I. Jones (chemistry), E. A. Guggenheim (physics), J. T. Irving (biochemistry), W. A. Waters (chemistry), H. T. Deas (classics), and J. C. Jones (physics); at King's College, A. Fletcher (mathematics), H. S. Kenward (classics), C. A. E. Lee (history), G. H. W. Rylands (English), and C. F. Sharman (physics); at Clare College, M. A. F. Barnett (physics). In addition, at certain colleges, notably Trinity College, scholarships are renewed for graduates doing research, so that there is a very marked move in the direction of the endowment of post-graduate research in Cambridge.

LEEDS.—An advanced course of twenty lectures on astronomy will be given on Monday evenings throughout the first and second terms of the session 1924–25, by Dr. S. Brodetsky, reader in applied mathematics, and Mr. R. Stoneley, assistant lecturer in applied mathematics and astronomical observer. Demonstrations will be given in the Cecil Duncombe Observatory. The syllabus includes lectures on such subjects as theories regarding the origin and age of the Solar System, stellar magnitudes, classification of spectra, distribution of stellar motions, double and variable stars, nebulæ, and so on. The lectures will assume such an elementary knowledge of astronomy as is represented by the popular courses given in the University. Advanced mathematical methods will not be used.

Dr. Albert Haworth has been appointed lecturer in chemical pathology. For three years Dr. Haworth has been on the staff of the Pathology Department of the Victoria University of Manchester.

LIVERPOOL.—The late Prof. Grenville A. J. Cole, Director of the Geological Survey of Ireland, and professor of geology in the Royal College of Science, Dublin, expressed a wish during his life-time that his valuable collection of separate geological papers should find a home in the University of Liverpool. After Professor Cole's death recently, his executors forwarded his collection of more than 3000 geological papers to the Department of Geology of the University.

LONDON.—Dr. Morris Ginsberg has been appointed as from August 1 to the University readership in sociology tenable at the London School of Economics.

The title of professor of electrical engineering in the University has been conferred on Mr. J. T. MacGregor-Morris, in respect of the post held by him at East London College.

The title of reader in physical chemistry in the University has been conferred on Mr. W. E. Garner, in respect of the post held by him at University College.

The title of reader in public administration in the University has been conferred on Mr. H. B. Lees-Smith, in respect of the post held by him at the London School of Economics.

The title of emeritus professor of education in the University has been conferred on Prof. J. W. Adamson on his retirement from the University chair of education at King's College.

Prof. H. R. Kenwood has resigned from the Chadwick chair of hygiene at University College as from December next. At a recent meeting, the Senate expressed appreciation of his long and valued services to the College and to the University.

The Senate has approved proposals for affording guidance to external students in their studies. The proposals are designed to meet the needs of those who are unable from any cause to follow courses of instruction either in Colleges or Institutions of the University, or in other universities, or in university colleges in other parts of the country. External students finding difficulty in arranging courses of study may consult the External Registrar.

The following Doctorates have been conferred: *D.Sc. in Physics*: Harry Moore (King's College), for a thesis entitled "The Corpuscular Radiation liberated in Vapours by Homogeneous X-Radiation"; *D.Sc. in Chemistry*: A. D. Mitchell, for a thesis entitled "The Reactions of Phosphorous and Hypophosphorous Acids, with Special Reference to the Evidence they afford for the Tautomeric Character of the Acids," and other Papers; *D.Sc. in Physics*: A. M. Mosharrafa, for a thesis entitled "The Quantum Theory of Radiation," and other papers.

MANCHESTER.—The following appointments have been made: Reader in surgical pathology, Mr. J. Howson Ray; Lecturers in surgical pathology, Mr. P. R. Wrigley and Mr. Garnett Wright; Assistant lecturers in chemistry, Mr. Wilson Baker and Mr. Bernard Cavanagh; Demonstrator in physiological chemistry, Dr. P. W. Clutterbuck. Prof. S. J. Hickson has been reappointed to the chair of zoology for a further period of two years.

ST. ANDREWS.—The Royal Commissioners for the Exhibition of 1851 have, on the nomination of the University Court of St. Andrews, awarded an industrial bursary of from £140 to £175 to Mr. Frank Gardiner Forbes, a student of engineering in University College, Dundee.

WALES.—Dr. E. H. Kettle has been appointed professor of pathology and bacteriology in the Welsh National School of Medicine (University of Wales), Cardiff.

SIR GILBERT T. WALKER, who has recently completed a period of about twenty years' service as director-general of Indian Observatories, has been appointed professor of meteorology at the Imperial College of Science and Technology, South Kensington, in succession to Sir Napier Shaw, who is retiring on August 31.

THE Higher Education Sub-Committee of the London County Council is recommending the Education Committee to award Robert Blair Fellowships, each of the value of 450*l*., to Mr. G. Bird and Mr. J. d'A. Clark. Mr. Bird, who is now with the Westinghouse Brake Company, will investigate signalling and train control problems in the United States, while Mr. Clark, who is at the Sittingbourne Paper Mills,

proposes to study the production of wood pulp in the large pulp mills of Canada.

THE Ramsay Memorial Fellowship Trustees have made the following awards of new fellowships for the session 1924–25, the place at which the award is tenable following the name of the Fellow in each case: British Fellowship of 300*l.* to Mr. S. W. Saunders—University College, London; Glasgow Fellowship of 300*l.* to Mr. A. Robertson—University of Manchester; Danish Fellowship of 229*l.* to Mr. K. J. Pedersen—University of Bristol. The following fellowships have been renewed: Dr. S. Coffey (British Fellowship)—University College, London; Dr. A. Titley (British Fellowship)—University of Oxford; Mr. Thomas S. Stevens (Glasgow Fellowship)—University of Oxford; Dr. Miguel Crespi (Spanish Fellowship)—University College, London; Dr. J. Kalff (Netherlands Fellowship)—University of Manchester; Dr. H. Weiss (French Fellowship)—Davy-Faraday Laboratory, Royal Institution; Dr. E. Boomer (Canadian Fellowship)—University of Cambridge. Sir Robert Robertson has been appointed a member of the Ramsay Memorial Advisory Council in succession to the late Sir James Dobbie.

IN "The Londoner's Education" (London, Hodder and Stoughton, pp. 58, 9*d.*), the Education Officer of the L.C.C. presents a popular account of the services of the Council as Local Education Authority, this being one of a series of handbooks "on the L.C.C. and what it does for London." The publication of these booklets is a new departure—interesting both as a means of promoting intelligent interest on the part of the citizens of London in the work of their local government and as a commendable example of municipal advertising. The writer lays stress on the admirable progress made in the field of elementary education and the wonderfully complete provision for defective and tuberculous children, London being in this respect able to challenge comparison with any city in the world. The expenditure on schools for these unfortunates is 4 per cent. of the total cost of the education service. The most remarkable thing about the appropriations of funds to the various kinds and grades of education is that the annual grants to the University of London and colleges and polytechnics for education of university standard amounts to only 0·7 per cent. of the total.

IN the early part of this year the Governing Body of the Imperial College of Science and Technology was enabled, by generous donations from the Rt. Hon. Sir Arthur Acland and Sir Otto Beit, to establish a scheme of ten Dominion scholarships for research work in science tenable at the College during the academic year 1924–25, open to university graduates in the several Dominions and in India. With the co-operation of the India Office and the Colonial Office respectively, appointments to these scholarships have now been made by the respective Governments as follows: *India*: Mr. Sarbbanisahay Guha Sircar (Calcutta University), and Mr. A. S. Gancean (University of Madras). *Australia*: Miss M. I. Collins (University of Sydney) (for work in economic botany, including forestry), and Mr. A. S. Fitzpatrick (University of Melbourne) (for work in applied chemistry, specially in relation to fuels). *Canada*: Mr. Armand Circe (École Polytechnique, Montreal), and Mr. R. J. Henry (University of Toronto). *New Zealand*: Mr. H. L. Richardson (Victoria University College, University of New Zealand), and Mr. H. O. Askew (Canterbury College, University of New Zealand). *South Africa*: Mr. Hans Pirow (for mining engineering), and Mr. Lawrence P. McGuire (for plant physiology).

Early Science at the Royal Society.

August 3, 1664. The experiment of the velocity of descending bodies was tried with three leaden balls of different sizes. The height of their descent was sixty-one feet. Mr. Hooke was desired to find some convenient place in Westminster or Paul's for the prosecution of these experiments in a place free from wind.

August 4, 1686. A letter of Mr. William Molyneux of Dublin, to Mr. Halley, was read, wherein he owned himself fully satisfied of the performance of Mr. Hooke's level; promised what account he could of the tides on the coast of Ireland, and gave his sentiments about the properest way for actual mensuration, in order to survey a degree of the earth.

August 5, 1663. Sir Gilbert Talbot received the thanks of the Society for sending them the mace, which his majesty had given them, without taking any fees.—Sir Robert Moray produced again the stones taken out of the Earl of Balcarre's heart, and desired that the figure of them might be drawn; and Dr. Wilkins moved, that it might be taken in plaister: the care of both which was committed to Mr. Hooke.

1682. Ordered—That the list be printed with several titles distinguishing all the fellows . . . and that a little mark be made before the names of such as have been benefactors, and such as frequently account for their arrears: and that the president intimate to the Society, that he hopes they will esteem such, who shew their affection to the Society this way, as more properly eligible for office.

August 6, 1662. Mr. Wilde was desired to communicate his method of laying leaf-copper without tarnishing.—Dr. Charlton was desired to give in writing the account of the boy killed by lightning.—Dr. Goddard brought in an account of his experiments of weighing glass canes with the cylinders of quicksilver in them, according to the Torricellian experiment; which was ordered to be registered.

1668. A microscopical observation devised by Mr. Hooke, was made on a little lump of charcoal of fir-wood, in which appeared here and there interstices or partitions intersecting the great pores. Several of the members saw it and were satisfied.—Several queries were proposed about the texture of trees.

August 7, 1661. Mr. Henshaw produced a stone called "Astroites" or "Lapis stellaris," of which the following account is registered; That it moved with a little vinegar upon a declining plate several times repeated; and that it was observed, that the stone grew somewhat hot, and brak at the top. It is to be remarked, that there are two sorts of "Astroites," the one marked with starry spots, and the other stellate in its form.—Dr. Wilkins was desired to try salt-petre in water, to see if it increased in bulk.

1679. The Society adjourned for the ensuing vacation, not to meet again till summons given; but such members as pleased to meet to discourse in the mean time, might do so at the repository or library on Thursdays in the afternoon, where there would be some entertainment for them.

August 8, 1666. The president reported, that the experiment mentioned April 18, 1666 by Mr. Povey, of a new way of laying on colours, had been made that morning by Mr. Streeter at his house before himself, Sir Robert Moray [and others] viz., that an egg was beaten yolk and white together, with a few shreddings of a fig-tree branch, whereby the egg was reduced into an oily substance, without any tenacity or ropiness, so that it would be ductile, and fall on the pencil like oil.

Societies and Academies.

LONDON.

Faraday Society, July 7.—Sir Robert Robertson, president, in the chair.—G. R. D. **Hogg**: A note on the conduction of heat down the necks of metal vacuum vessels containing liquid oxygen. Approximate methods are given for calculating the "neck loss" of metal Dewar flasks containing liquid oxygen. These may also be used for determining the most suitable dimensions for the inner neck of a metal Dewar flask, the other dimensions of which are known. —C. L. **Haddon**: The mechanism of setting of calcium sulphate cements. There are fundamental differences in the hydration processes between plaster of Paris, flooring plaster and anhydrite Further evidence in favour of Desch's theory of crystal thrust as the cause of expansion is put forward. There is a similarity between the coherence of calcium sulphate cements and that of metals.—J J. **Doolan** and J. R. **Partington**: The vapour pressure of tellurium. The vapour pressure of sulphur has been determined in various ways, and at least one determination of that of selenium has appeared. The vapour pressure of tellurium, however, has, apparently, not previously been measured. Its value, at least approximately, has been determined at different temperatures.—E. E. **Turner** and W. H. **Patterson**: Cryoscopy in sodium sulphate decahydrate. The molecular weights of a number of sodium salts have been determined, using sodium sulphate as cryoscopic solvent, a method first investigated by Löwenherz, whose results have, in general, been confirmed. Abnormal results were obtained for the molecular weights of sodium oxalate and borax. The low result for the former substance is not due to solubility effects, whilst the molecular weight obtained for borax is in good agreement with the value obtained by Boutaric, Chauvenet, and Nabot, using sodium thiosulphate as solvent.—D. B **Macleod**: The viscosity of binary mixtures.—J. B. **Firth** and F. S. **Watson**: The catalytic decomposition of hydrogen peroxide solution by animal charcoal; the production of highly active charcoals.—A. J. **Allmand** and A. N. **Campbell**: The electro-deposition of manganese. The best conditions for the electro-deposition of pure manganese consist in the electrolysis of a solution containing manganous and ammonium sulphates (the catholyte) separated by a diaphragm from the anolyte (ammonium sulphate solution), the H· concentration being kept at 10^{-6} to 10^{-8} by the regulated addition, as required, of sulphuric acid or of ammonia. The temperature is 30° C. and the current density at the cathode 10-15 amps./d.m. The rotating aluminium cathode has a burnisher lightly pressing against it. Electrolyte manganese contains a considerable quantity of dissolved hydrogen, which is not, however, responsible for its brittle nature.—J. **Grant**: Concentration-cells in methyl alcohol. Part II. Solutions containing tetraethyl ammonium iodide.—F. H. **Jeffery**: The electrolysis of solutions of potassium oxalate with a tin anode, and an electrometric determination of the constitution of the complex anions formed. Electricity passes from anode to anolyte in accord with the equation—

$$Sn + 2C_2O_4'' - 2\ominus = \{Sn(C_2O_4)_2\}''.$$

A solid phase corresponding with this complex ion,

$$K_2\{Sn(C_2O_4)_2\}.H_2O,$$

can be isolated. When the tin anode is coated with finely divided metal and the products of electrolysis allowed to accumulate on it, anodic oxidation takes place probably in accord with the equation—

$$\{Sn(C_2O_4)_2\}'' + C_2O_4'' - 2\ominus = \{Sn(C_2O_4)_3\}''.$$

A solid phase derived from tetravalent tin is formed, but it has not been determined whether it is of the form $Sn(C_2O_4)_2$ or $K_2\{Sn(C_2O_4)_3\}$. No tin is deposited on the cathode during this stage. The anode potential remains constant for a wide range of current density provided the anode be kept free from finely divided metal and the products of the electrolysis: failing this precaution it may rise to more than nine volts referred to the normal hydrogen electrode as zero, the current being 0·1 amp. The Darwin thread recorder has been adapted to the measurement of variations of the electrolysis current and also the time-integral of this current. It shows the rapidity of the change from the stage of the formation of the stanno complex alone to the stage of anodic oxidation.—F. J. **Fraser**: An improved form of Crook's elutriator.

CAMBRIDGE.

Philosophical Society, July 14.—Mr. C. T. Heycock, president, in the chair.—E V. **Appleton**, K. G. **Emeléus**, and M. **Barnett**: Some experiments with an α-particle counter. The "wave-form" and intensity of the transient impulses resulting from discharges stimulated by single electrified particles have been determined using a cathode-ray oscillograph The nature of the impulse is determined largely by the capacity and resistance of the system. The potential impulse normally detected by string electrometer methods is proportional to the current responsible for the re-charging of the electrostatic capacity of the counter after the rapid discharge of the capacity initiated by the electrified particle. When the pressure in the ionisation chamber is made less than that at which self-restoring action is possible, persistent oscillations are found. These represent the periodic charging of the counter capacity after its periodic discharge between the point and the plane. The impulses normally produced by α-particles are thus represented by one unit of the sustained oscillation. The total quantity of electricity circulating round the system when an α-particle enters the chamber is, in normal cases, of the order of 10^{-10} coulomb, but in low resistance circuits may be made 10^{-6} coulomb. The "energy trigger ratio" of the counter for α-particles, which represents the ratio of the energy released in the system to that of the electrified particle acting as stimulus, is normally of the order of 10^5, but may be made as high as 10^9.—J. E. **Littlewood**: On the zeros of the Riemann zeta function.—S. **Lees**: A case of steady flow of a gas, in two dimensions.—P. A. M. **Dirac**: Note on the Doppler principle and Bohr's frequency condition.—B. M. **Sen**: The applicability and deformation of surfaces.—E. C. **Titchmarsh**: A system of linear equations with an infinity of unknowns.—J. B. S. **Haldane**: A mathematical theory of natural and artificial selection. Part II. Expressions are found for the effects of various degrees of self-fertilisation, inbreeding, assortative mating, and selective fertilisation, on the composition of Mendelian populations, and the progress of natural selection in them.—H. W. **Turnbull**: The vector algebra of eight associated points, of three quadric surfaces.

CALCUTTA.

Asiatic Society of Bengal, July 2.—Gilbert T. **Walker**: On the wings of gliding birds. A peculiar feature in the structure of the wings of gliding birds is comparable to a device adopted in the construction of Handley-Page aeroplane wings.—E. W. **Gudger**: The sources of the material for Hamilton-Buchanan's "Fishes of the Ganges," the fate of his collections, drawings and notes, and the use made of his data.—

L. M. **Davies**: Notes on the geology of Kohat, with reference to the homotaxial position of the salt marl at Bahadur Khel. The beds at Kohat are homotaxial with the beds at Bahadur Khel.—Baini **Prashad**: Revision of the Japanese species of the genus Corbicula.—W. **Ivanow**: (1) More on the sources of Jami's "Nafahat." A summary description of the rare work, Risāla-i-Iqbālıyya, containing an account of the discourses of 'Alāu'd-Dawla Samnānī (d. 1336). (2) Imam Ismail. New information concerning Ismail, the sixth Imam of the Ismailiyya. It was found in a rare and early book on Shi'ite tradition, by Kashī, dating from the tenth century.—K. N. **Dikshit**: Two Harsola copper-plate grants of the Paramara Sikaya (II.), V S. 1005.—Amareshvar **Thakur**: Jail administration in ancient India. A brief review, mainly based on data furnished by the Buddhist Jātakas and Kautilya's Arthasāstra, drawing the conclusion that a humane element was not wanting in ancient Indian criminal justice.—Sir Gilbert T. **Walker**: A note on Indian boomerangs. Description, with illustration, of a new species, called *Kâtar*, used as a throwing stick by the Bhils.—Paul **Tedesco**: The dialectical position of Ormurī.—N. G. **Majumdar**: A list of Kharosthī inscriptions.—H. Srinivasa **Rao**: Note on a brackish-water actinian from Madras. A form apparently new to science, probably closely allied to *Pelocoetes*, which was collected in 1922, was described.—H. **Chaudhuri**: *Oedogonium Nagii sp. nov.* Found at Lahore, developing in a bottle containing a collection of Zygnemas.

OTTAWA.

Royal Society of Canada (Section V., Biological Sciences), May 19-22 (Annual Meeting at Quebec).—F. C. **Harrison** (Presidential Address): Historical review of the red discoloration of foodstuffs.—A. H. Reginald **Buller**: (1) Luminous leaves; (2) *Sphærobolus stellatus* and the dispersion of its spores by herbivorous animals.—C. W. **Lowe**: The fresh-water algæ of Central Canada.—B. T. **Dickson** and G. A. **Scott**. Identity of the organism causing black-dot disease of the potato, Part I. and Part II.—B. T. **Dickson** and W. L. **Gordon**: The effect of various smut control treatments on the germination of oats.—C. D. **Kelly**: The bacteriology of the Kingston cheese.—N. S. **Golding**: A study of the moulds in blue-veined cheese.—A. G. **Lochhead**: (1) Microbiological relationships in frozen soils; (2) Psychrophilic soil bacteria.—G. W. **Scarth**: The toxic action of distilled water and the antagonism to it of cations.—A. B. **Macallum**: The origin of karyokinesis.—A. T. **Cameron** and J. **Carmichael**: After-effects of feeding thyroid to young rats.—A. T. **Cameron**: (1) The action of absorbable intestinal toxins on metabolism; (2) The cranio-facial axis of Huxley—Pt. I., Embryological considerations.—J. G. **FitzGerald** and Dorothy G. **Doyle**: A further study of the question of utilisation ("fermentation") of saccharose by *B. diphtheriæ*.—J. J. R. **Macleod**, J. **Hepburn**, J. K. **Latchford**, and N. A. **McCormick**: The effect of insulin on the percentage of sugar in blood from different regions of the body.—J. J. R. **Macleod**, E. C. **Noble**, and M. K. **O'Brien**: The influence of insulin on the glycogen content of the liver and muscles during hyperglycæmia.—G. S. **Eadie**, J J. R. **Macleod**, and M. D. **Orr**: The soluble carbohydrates of liver and muscle and the influence of insulin on them.—F. N. **Allan** and S. S. **Sokhey**: Further observations on depancreatised animals.—S. U. **Page**: The effect of insulin on chloridzin diabetes in dogs.—J. **Markowitz**: The behaviour of the diastases in diabetic animals treated with insulin.—Frederick R. **Miller** and H. M. **Simpson**: Viscero-motor reflexes.—R. **Miller** and R. A. **Waud**: Pulse and cardiac records obtained with electropolygraph.—G. A. **Ramsay**: Amplification of heart sounds by radio apparatus.—J. **Miller**: Classification of tumours arising from the trophoblast, with illustrative cases.—C. McLean **Fraser**: *Acaulis Primarius*, Stimpson.—A. G. **Huntsman**: Some results of the Belle Isle Strait Expedition, 1923.—R. H. **McGonigle**: The distribution of pile borers on the Canadian Atlantic coast.—A. H. **Leim**: Certain features in the life-history of the shad.—A. G. **Huntsman** and M. I. **Sparks**: Resistance of marine animals to high temperatures, and their distribution in Nature.—C. H. **O'Donoghue**: A list of the Nudibranchiate Mollusca recorded from the Pacific coast of North America, with a note on their distribution.

VIENNA.

Academy of Sciences, January 10.—Kurt **Ehrenberg**: On the development of the base of the skull in cave bears from the Drachenhöhle near Mixnitz. The communication is chiefly concerned with the confirmation of a hitherto unobserved epiphysis formation in the lower half of the posterior head condyles of the cave bear (*Ursus spelaeus*), which appears during the second year of life. Later the epiphysis fuses completely with the original condylus occipitalis. Its formation is conditioned by a change in the attitude of the skull, a downward inclination of the skull as it becomes heavier, and appears to have arisen only in the males.—A. **Skrabal** and H. **Airoldi**: On the rate of hydrolysis of ethyl ether.—A. **Skrabal** and M. **Baltadschiewa**: On the rate of hydrolysis of orthoacetic-ethyl ether.—R. **Andreash**: Note on the paraban acids.—R. **Andreasch**: On the carbamide and guanidin derivatives of the sulphur-substituted fatty acids; Part II.—E. **Muller**: On combined conic sections of conic section pencils.—K. **Ehrenberg**: On the development of the anterior region of the skull of the cave-bear from the Drachenhöhle near Mixnitz.—A. **Pisek**: The development of the anthers and the meiotic division of the pollen mother cells in the juniper-mistletoe, *Arcenthobium Oxycedri*; the structure of the anthers and the number of chromosomes in the cells of *Loranthus europæus*. The anther of Arcenthobium is regarded as equivalent to a microsporangium. The meiotic division of the pollen mother-cells sometimes shows disturbances caused by insufficient nourishment of the parasite by the host plant.—R. **Kreman**, R. **Kienzl**, and R. **Markl**: Electrolytic conduction in fused alloys; Part III., The electrolysis of lead-cadmium and of lead-sodium-cadmium alloys. With currents of about 1 amp. per sq. mm., an increase in the concentration of lead was found to occur at the anode and of cadmium or sodium respectively at the cathode.

January 17.—R. **Kreman**, R. **Müller**, and H **Kienzl**: Electrolytic conduction in fused alloys; Part IV., The electrolysis of mercury-sodium alloys. The increase in concentration of sodium at the cathode and of mercury at the anode was found to grow with the density of the current to a maximum of about 9 per cent.—R. **Kreman**, R. **Muller**, and R. **Ortner**: Electrolytic conduction in fused alloys: Part V., The electrolysis of mercury alloyed with potassium, calcium, and cadmium. An increase in the concentration of potassium, calcium, and cadmium is observed near the anode, the effect increasing with the density of the current.—L. **Moser** and A. **Brukl**: On solid compounds of hydrogen and arsenic. The formation of solid As_2H_2 according to Reckleber and Scheiber is confirmed. A new solid compound, tetra-arsenic hydride As_4H_2 was obtained by the use of weak oxidising agents on gaseous AsH_3.—K. **Schnarf**:

Remarks on the position of the genus Saurania.—K. **Keissler**: Fungi novi Sinenses a H. Handel Mazzetti lecti II.

January 24.—H. **Micoletzky**: Final report on free-living nematodes from Suez. The Mediterranean and the Red Sea appear to have more nematodes in common than the Mediterranean and the North Sea.—G. **Götzinger**: Morphological studies after the great landslide of the Gras-mountain at Oberwang in Attergau.—H. **Handel-Mazzetti**: Plantæ novæ Sinenses diagnosibus brevibus descriptæ.

February 7.—F. **Werner**: New or little known snakes from the State Museum of Natural History at Vienna. New genera of aglyptic Colubrides, *Procteria viridis* (n. sp.), South-west Africa, allied to *Pseudoxenodon*, *Pachyophis temporalis* (n. sp.), *Triænopholis arenarius* (n. sp.), *Aryrogena rostrata* (n. sp.), Argentine, *M. elegantissima* (n. sp.), *Pseudoromacer lugubris* (n. sp.), San Paolo, Brazil, *Nerophidion hypsirhiroides* (n. sp.), allied to *hydræthiops*, *Padangia pulchra* (n. sp.), Padang, Sumatra, *Eoninophis lineolata* (n. sp.), East Africa.—A. **Skrabal** and M. **Baltadschiewa**: On the rate of hydrolysis of ortho-carboxyl-ethyl-ether.—A. **Skrabal** and A. **Matievic**: The dynamical equilibrium of malic ester.—E. **Schweidler**: Studies in atmospheric electricity, No. 65, On the characteristics of the current in slightly ionised gases. The characteristic of the ions is calculated by linear recombination law and the proportionality between conductivity and the saturation deficit of the current is found to hold. The term semisaturation potential (corresponding to 50 per cent. saturation) is defined. The application to practical measurements is demonstrated.—W. **Schlenck**: Studies in atmospheric electricity, No. 66, Experimental investigations on the characteristic of the current in weakly ionised gases. With a cylindrical condenser as ionising vessel, the current-potential function was found to correspond to the linear law of recombination.—M. **Blau**: On the disintegration constant of radium A (Mitt d. Ra-Inst's No. 161). A new experimental determination gives the radioactive constant . . . $\lambda = 0{\cdot}2273 \pm 0{\cdot}0007\ \mathrm{min}^{-1}$; the half value period was found to be $T = 3{\cdot}05 \pm 0{\cdot}009$ min.—W. **Riss**: On the composition of bröggerites and on the genetic relationship between thorium and uranium (Mitt. d. Ra-Inst's No. 162). A large number of analyses on bröggerites have proved that idiomorphic bröggerites are probably all (many of them without doubt) older than the lodes in which they are found. As there are also non-idiomorphic bröggerites, it remains an open question whether these can be used for age measurements and also whether the large differences in the ages of the lodes found in this way are real. The results do not contradict the assumption of a genetic relationship between thorium and uranium.—E. **Lohr**: On the comparison made by Fr. Schenner between the Jaumann's theory of gravitation and observations.—G. **Flumiani**: On a dimethyl - tetroxy - anthrachin. — K. **Brunner**, W. Seeger, S. **Dittrich**: Diacyamine.—A. **Tauber**: On the integration of linear differential equations, IV.—O. **Storch**: Studies on dragonflies from the biological station at Lunz, Lower Austria, and the second Zoological Institute of the University of Vienna. *Somatochlora metallica*, an anisopterate odonate, lays its eggs in the earth inserting its ovipositor in the intervals of its flights over water. The Odonata anisoptera are not gliding air-machines; they make the best use of the freedom of movement which their mode of flight permits, lifting themselves straight into the air and performing all sorts of evolutions during oviposition.—F. M. **Exner**: On the release of cold and warm outbursts in the atmosphere.—F. **Feigl**: Contributions to the study of the relationship between the grouping of atoms and specific affinity, Part I.

February 17.—P. **Weiss**: (1) Regeneration of the whole from half the cut surface of an extremity in *Triton cristatus* (from the Institute of Experimental Biology of the Academy of Science, Vienna). If the leg be split and both parts shortened by amputation, a whole foot will regenerate from the half-cut surface when the second half regenerates nothing; otherwise regeneration of a whole foot occurs, divided between the two stumps, forming a split extremity or merging into one blastema. (2) Regeneration from a double cut surface of an extremity in *Triton cristatus*. When the arm is artificially bent in such a way that the radius lies parallel to the humerus, fixed in such a position, and the elbow cut off, exposing two cut surfaces, one from the humerus, one from the lower arm, a symmetrical structure regenerates, the regenerating part from one cut surface being the mirror image of the other.—I. **Sciacchitano**: The stage in which dopa is formed in the cocoon of the moth *Lophyrus pini* (from the Institute for Experimental Biology of the Academy of Science, Vienna). Dopa, *i.e.* dioxy-phenyl-alanin, is only produced in the caterpillar during spinning and is already lost when the state of pupation is attained.—L. **Kober**: Contribution to the geology of anomalies in the gravitational force.—A. **Kohler**: Petrographic-geologic observations in the south-western forest district.—L. **Kolbl**: Report from petrographic-geological studies in the western part of the forest district in Lower Austria.—L. **Waldmann**: Preliminary report from the survey of the Moravian district to the south of the Eggenberg-Siegsmundherberg railway line.

February 21.—A. **Skrabal**, F. **Pfaff**, and H. **Airoldi**: On saponification of keto-carbonic-ester.—H. **Lieb** and D. **Schwarzl**: On elemic acid from Manila elemi-resin.

Official Publications Received.

Bulletin of the American Museum of Natural History. Vol. 51, Art. 1: Miocene Oreodonts in the American Museum. By F. B. Loomis. Pp. 37. (New York City.)

University of Illinois Engineering Experiment Station. Circular No. 11: The Oiling of Earth Roads. By Prof. Wilbur M. Wilson. Pp. 27. (Urbana, Ill.) 15 cents.

Colony of Southern Rhodesia. Report of the Director of Veterinary Research for the Year 1923. Pp. 8. (Salisbury, S. Rhodesia: Government Printer.)

Memoirs of the Department of Agriculture in India. Botanical Series, Vol. 13, No. 2: The Wilt Disease of Safflower. By S. D. Joshi. Pp. 39-46+3 plates. (Calcutta: Thacker, Spink and Co., London: W. Thacker and Co.) 1 rupee; 1*s*. 6*d*.

Smithsonian Institution: United States National Museum. Contributions from the United States National Herbarium. Vol. 24, Part 5: Economic Fruit-bearing Plants of Ecuador. By Wilson Popenoe. Pp. x+101-134+plates 34-49. (Washington: Government Printing Office) 15 cents.

The South African Journal of Science. Vol. 20, No 2, December 1923: Comprising the Report of the Twenty-first Annual Meeting of the South African Association for the Advancement of Science, Bloemfontein, 1923, July 9-14. Pp iv+285-604 (Johannesburg) 15*s*. net.

Experimental and Research Station, Nursery and Market Garden Industries' Development Society, Ltd., Turner's Hill, Cheshunt, Herts. Ninth Annual Report, 1923. Pp 97. (Cheshunt, Herts.)

Proceedings of the Royal Society of Edinburgh, Session 1923-1924. Vol. 44, Part 2, No. 15: An Investigation into the Structure and Life-History of the Sulphur Bacteria (I.). By Dr. David Ellis. Pp. 153-167. (Edinburgh: R. Grant and Son; London: Williams and Norgate.) 1*s*. 3*d*.

The Organization, Achievements and Present Work of the Dominion Experimental Farms. Pp. 302. (Ottawa: Government Printing Bureau.)

National Association of Master Bakers, Confectioners and Caterers. Reports on Research at the National Bakery School, London, conducted by Dr. C. Dorée and John Kirkland. Pp. 26. (London: 89 Kingsway, W.C.2) 2*s*. 6*d*.

Department of the Interior: Bureau of Education. Bulletin, 1923, No. 58: Statistics of Kindergartens 1921-22. Prepared by the Statistical Division of the Bureau of Education under the Direction of Frank M. Phillips. Pp. 7. (Washington: Government Printing Office.) 5 cents.

Proceedings of the Academy of Natural Sciences of Philadelphia. Vol. 75, 1923. Pp. iii+429+29 plates+87. (Philadelphia.)

Ministère de l'Instruction publique et des Beaux-Arts Enquêtes et documents relatifs à l'enseignement supérieur. 119: Rapports sur les observatoires astronomiques de Province, année 1923. Pp. 129. (Paris: Imprimerie Nationale.)

Rapport annuel sur l'état de l'Observatoire de Paris pour l'année 1923, présenté au Conseil dans sa séance du 14 février 1924. Par M. B. Baillaud. Pp. 43 (Paris: Imprimerie Nationale.)

NATURE

SATURDAY, AUGUST 9, 1924.

CONTENTS.

Editorial and Publishing Offices :
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.

Editorial communications should be addressed to the Editor.
Advertisements and business letters to the Publishers.

Telephone Number : GERRARD 8830.
Telegraphic Address : PHUSIS WESTRAND, LONDON.

Science and Life.[1]

THERE has been no niggardliness in the intellectual menu provided for the Toronto visit of the British Association. There is plenty to masticate, and there are also delicacies. But the metaphor is dangerous, and we let it drop. The president, Sir David Bruce, strikes the humane note, "Science for Life," in his fine address. In the long run, man wins against microbe; thus Malta, once the most deadly of foreign stations, becomes a health resort; Malta fever is beaten in the first round. Anti-typhoid inoculation was one of the outstanding victories of the war, and the anti-toxin treatment of tetanus was another. The prevention of tuberculosis depends fundamentally on improved environment and on the education of the people in the art of health. The protozoal infectious diseases, like the bacterial, are being mastered—witness sleeping sickness and malaria. Successful attacks are being made on the undetermined group of infectious diseases, probably due to "filter-passer" germs, such as trench fever and typhus fever. Here the zoologists have to be thanked for their discovery and tracking of the insect and mite carriers; and what shall we say of the attacks on deficiency diseases, whether the standard of victory bears the legend "vitamins," "balanced nutrition," or "endocrine glands"? "Man has come into his heritage."

Prof. J. W. Gregory, addressing the Geography Section, brings us back to the idea of "Control." He seeks to show that, if due care be taken, the white man is not physiologically disqualified from manual labour in the tropics. This simplifies inter-racial problems, as it provides an additional outlet and a spacious home for the European race. The world has reached its present position by help of each of the three great races, and it still needs the special qualities of each of them—the contemplative Asiatic, who founded religions; the artistic Negro, who probably gave the world the gift of iron, and the administrative European, who has organised the brain power of the world. But "the affectionate, emotional Negro, the docile, diligent Asiatic, and the inventive, enterprising European do not work at their best when associated in mass." Individual association there must be, but co-residence *in mass*—that way lies trouble. But will the clock stand the implied turning back of its hands, and will our hygienically resolute swarming into the tropics stop short of being massive?

In his careful address to the Anthropology Section, on health and physique through the centuries, Dr. F. C. Shrubsall showed that Britain is *not* going to the dogs. "A pessimistic view of the physical or mental condition of the people of England is unnecessary and unfounded." Stature and weight are not less than in the days of Agincourt; the general health of the nation is better and the expectation of life longer than ever before; the real increase of the unfit is much less than has been assumed on a priori arguments; the dysgenic tendencies of industrialism are being successfully opposed. Not that Dr. Shrubsall is satisfied with things as they are. His thesis, well documented, is

[1] The Advancement of Science, 1924 · Addresses delivered at the Annual Meeting of the British Association for the Advancement of Science (94th Year), Toronto, August 1924. Pp. iv+33+19+36+20+16+24+30+12+21+15+7+14+9+14. (London: British Association, 1924.) 6*s*.

that they are not nearly so bad as some Cassandras make out.

An inspiring address to the Physiology Section by Dr. H. H. Dale dealt with the progress and prospects of chemotherapy. " Science for Life " again ! Chemotherapy in general is the specific treatment of infections by artificial remedies, but Dr. Dale was picturing the systematic chemotherapy which the genius of Ehrlich revealed, " the production by syntheses of substances with a powerful specific affinity for, and a consequent toxic action on, the protoplasm of the parasites, and none for that of the host." What Ehrlich was in search of were introduceable substances, which, as he said, should be maximally parasitotropic and minimally organotropic. What makes the difference is a biochemical problem still unsolved, but contributions to the reading of the riddle are rising above the horizon.

" As the biological complexity of the problem is realised, it becomes increasingly a matter for wonder and admiration that so much of practical value has already been achieved—the treatment of the spirochætal infections, syphilis, yaws, and relapsing fever, revolutionised ; Leishmania infections, kala-azar and Baghdad boil, and Bilharzia infections, which crippled the health of whole populations in countries such as Egypt, now made definitely curable ; trypanosome infections, such as the deadly African sleeping-sickness, after years of alternating promise and disappointment, brought now at last within the range of effective treatment."

Such achievements, we must remember, have rewarded experiment during a period—does it ever end ?—when practice outran theory. What victories may be looked for when a fuller understanding affords not only tactics, but also strategy. This address will appeal to many very strongly with its Pisgah view of a Promised Land with no unconquered infectious diseases.

To the Botanical Section Prof. V. H. Blackman gave an address which does not sound like botany at all, it is so interesting. There is nothing in it about a " hortus siccus," and it is impossible not to be thrilled by the account of the unending attacks which the parasites make on the capitalists.

One of the peculiarities of parasitic diseases in plants, as contrasted with those of animals, is that the plant seems to give the same answer back to quite different invaders. Among animals, if certain symptoms appear, one can, in most cases, infer the presence of a certain parasite, but in plants a large number of infectious diseases display the same symptoms. This makes the practice of medicine among plants much more difficult than among animals. Another difference is that the acquired immunity due to one attack of a disease which is so common in animals is quite unknown in plants. Again, owing in part to the absence of a circulating blood-stream, the plant makes a local rather than a general reaction to the infectious disease.

Immunity and resistance to diseases are, of course, well known among plants, but they illustrate *natural*, not acquired immunity. There may be some physical barrier which resists the entry of the parasite, or the entry may call forth a wound reaction leading to the production of cork which checks further advance. This natural resistance may be increased by good cultivation, or Mendelian breeding may build up a plant synthetically which is resistant to various intruders, but there seems to be no hope of finding a way of endowing plants with artificial disease-resistance.

As Lord Kelvin was born a hundred years ago and as Faraday discovered the principle of the electromotor in 1821, it was very appropriate that Prof. G. W. O. Howe should address the Engineering Section on " A Hundred Years of Electrical Engineering." He tells a story of fascinating interest—a story that mankind may well be proud of. It is a record of "the mastery of man over the resources of nature, and in the use of these resources to the amelioration of the conditions of life." Every one knows part of the story, but a general review is very eloquent.

" By the aid of electricity the energy of the coal or of the lake or river a hundred or even two hundred miles away is transmitted noiselessly and invisibly to the city, to supply light and warmth, to cook the food, to drive the machinery, to operate the street-cars and railways." We flash intelligence to the most distant parts of the globe ; we talk to our friends hundreds or even thousands of miles away ; at small cost we can equip ourselves with what may almost be regarded as a new sense. " Whereas thirty years ago a ship at sea was completely isolated from the life and thought of the world, it is now in continuous communication with the land and with every other ship within a wide range."

In no branch of electrical engineering is there any suggestion of having reached a limit ; rapid development is taking place in every direction.

Prof. William McDougall spoke of " Purposive Striving as a Fundamental Category of Psychology." The life of man from birth to death is one long series of purposive strivings. Even in his dreams the striving goes on. This must be recognised as an all-important aspect, corrective to the picture of man as " a bundle of mechanical reflexes, a superior penny-in-the-slot machine, whose workings are mysteriously accompanied by various ' elements of consciousness.' " The address may be described as a plea for more courage in psychology, which is spoken of as " the most concrete of the sciences."

Three of the addresses of presidents of Sections will not be delivered until Monday, August 11, so we cannot deal with them this week : they are by Sir William Bragg on the analysis of crystal structure by X-rays, by Prof. F. W. Gamble on construction and control in animal life, and by Sir John Russell on present-day problems in crop production. We are reluctantly forced to pass over here the other presidential addresses, —by Sir Robert Robertson on chemistry and the State, by Prof. W. W. Watts on geology in the service of man, by Sir W. Ashley on Free Trade doctrine, and by Principal E. Barker on academic freedom in universities, but summaries of them will be found in the Supplement to this week's issue. They are as interesting and as important as those of which we have given glimpses, and Toronto cannot complain of having been offered " second best " material. There is a very high standard throughout. There is also an interesting unity, for most of the addresses come round to this, that man conquers by understanding. The people perish for lack of knowledge ; but science is for life, even for the life that is more than meat.

Where Philosophy joins Forces with Mathematics.

Substance and Function and Einstein's Theory of Relativity. By Ernst Cassirer. Authorised translation by Dr. William Curtis Swabey and Dr. Marie Collins Swabey. Pp. xii+465. (Chicago and London: The Open Court Publishing Co., 1923.) 3.75 dollars.

THE translators of Prof. Ernst Cassirer's most important contributions to mathematico-logical theory have done well to issue his "Substanzbegriff und Fonktionsbegriff" and his "Zur Einsteinschen Relativitätstheorie" together in one volume, although a considerable time interval separates the two works. The first appeared in 1910, the second in 1921, and the interval covers the formulation by Einstein of the new theory of gravitation. By presenting the two together, the philosophical significance of the principle of relativity and the intimate connexion of its mathematico-physical form with the logico-epistemological form of the philosophical problem are clearly brought out. The translation has succeeded in reproducing the clear scientific expression of the German and reads like an original English work. For an American publication there are singularly few Americanisms in the text. It is very unfortunate, however, that the word "Begriff" is not retained in the English title. The book is not about substance and function but about the concept; substance and function are meant to be adjectival, not substantival terms.

Prof. James Ward, in his recent most illuminating work, "A Study of Kant," has shown very clearly how Kant's interest in natural science and desire to discover its metaphysical basis were the original motive and directing force of his philosophy. Prof. Cassirer enables us to see the real significance of the Kantian doctrine in its relation to physical theory. The transcendental æsthetic was not, as often represented, a subjective idealism in regard to the concepts of space and time; on the contrary, it was a justification of the objective use of those concepts and intended to rationalise the Newtonian doctrine and provide a philosophical basis for the Newtonian physics. The attempt of Kant in the transcendental analytic to provide the necessary scientific categories is still more striking. It is curious to follow the complete transformation which has overtaken the chief doctrines of formal logic since he took it as the type of the perfect science, the science which since Aristotle had not had to advance or retrace a single step. This is Prof. Cassirer's starting-point. He shows how the Aristotelian logic depends on the Aristotelian metaphysics, how this accepts the substantival aspect of the world as given fact and the work of thought as discovery, and he traces the steps and stages by which in modern mathematical and logical theory, since Kant (and even before Kant, for the essential change of direction is found in Descartes and Leibniz), the whole position has been reversed.

The fundamental thought of logical idealism is most strikingly exhibited in mathematical theory. "More and more the tendency of modern mathematics is to subordinate the 'given' elements as such and to allow them no influence on the general form of proof." The concept of magnitude gives place to the concept of function; quality, not quantity, is the real foundation of mathematics. In place of the analysis of parts there appears the resolution into concepts.

How do we form concepts, and what purpose do they serve? The two questions are really one, the fundamental problem of the nature of the physical world which is the basis of physical science. Two principles seem equally insistent. One holds us firmly to concrete experience. The concept seems empty and meaningless which does not deepen and enrich our intuition. Yet when we turn to the mathematical concepts, and especially to the meaning of number, we seem to grasp this meaning completely only when thought has freed itself from seeking in concrete experience a correlative for its constructions. We are left to choose between two views of the world: either the empirical view that the only existent is what we can point to as an individual in a real presentation, or the idealist view that what really exist are intellectual structures which can never themselves be presented. Mathematics will not solve the riddle. All it can do is to lay bare the ultimate intellectual roots of our analysis of experience.

What then is the relation of mathematics to physics? The advance of theoretical physics has completely superseded the old view that measurements inhere in physical things and are just read off. The intellectual work of understanding a bare fact presented in sense-experience as an entity or empirical object only begins when the fact is replaced by a mathematical symbol. For the physicist the individual thing is a system of physical concepts. To distinguish one object from another, he must subsume it under a conceptual class. He analyses the object into the totality of its numerical constants; he does not break it up into the group of its sensuous properties. The thing changes from a sum of properties into a mathematical system of values established with reference to a scale of comparison. The constitutive parts of

the perception are left completely out of account, and the mathematical symbol which constitutes the object a member of a system is taken as the real kernel of empirical reality. It is only when we bring the given under some norm of measurement that it gains fixed shape and form and has clearly defined properties. The metaphysical concept of substance, which natural science always clung to, has been displaced in the progress of science itself.

It is not possible to give more than an indication of the important contemporary work on methodology and philosophy of science which is surveyed and systematised in this book. Most students will probably turn first to what is described as a supplement, the essay on "Einstein's Theory of Relativity from the Epistemological Standpoint." The value of this essay is enhanced by the fact that Einstein himself read it in manuscript and gave the author the benefit of his criticisms. It is, Prof. Cassirer tells us, at first sight somewhat strange and paradoxical that such diverse epistemological points of view as those of radical empiricism, positivism, and critical idealism should all have appealed to the theory of relativity in support of their fundamental views. The reason is that they all appeal to experience and they all teach that every exact measurement presupposes universal empirical laws. The real problem is how we reach those laws and what sort of validity we grant them. For positivism they are grounded in sensation and never go beyond its domain; for idealism all equations are results of measurement. We neither measure mere sensations nor do we measure with mere sensations; relations of measurements transcend the given and replace perception with a conceptual symbol. The typical example is the development of modern physics in the theory of relativity.

A quotation better than any description will give an insight into the author's own philosophical point of view:

"Only the idealistic concept of truth overcomes finally the conception which makes knowledge a copying, whether of absolute things or of immediately given 'impressions.' The 'truth' of knowledge changes from a mere pictorial to a pure functional expression. In the history of modern philosophy and logic, this change is first represented in complete clarity by Leibniz, although in his case the new thought appears in the setting of a metaphysical system, in the language of the monadological scheme of the world. Each monad is, with all its contents, a completely enclosed world, which copies or mirrors no outer being but merely includes and governs by its own law the whole of its presentations; but these different individual worlds express, nevertheless, a common universe and a common truth."

H. WILDON CARR.

The Cheyenne Indians.

The Cheyenne Indians: their History and Ways of Life. By G. B. Grinnell. Vol. 1. Pp. ix+358+23 plates. Vol. 2. Pp. vii+430+25 plates. (New Haven: Yale University Press; London: Oxford University Press, 1923.) 45*s*. net.

MR. GRINNELL has spent some time each year with the Cheyenne Indians ever since 1890, and in this way he has come to know them as few others can have done. As he says himself:

"I have never been able to regard the Indian as a mere object for study—a museum specimen. A half-century spent in rubbing shoulders with them, during which I have had a share in almost every phase of their old-time life, forbids me to think of them except as acquaintances, comrades, and friends." Yet he can say, "I am constantly impressed by the number of things about the Indians that I do not know."

He has embodied the results of his study in two large and interesting volumes, which deal with all aspects of the life of this tribe, and it may come as a surprise to many to realise how much of the old life still exists. Mrs. Grinnell and Mrs. J. E. Tuell have enriched the book with numerous photographs of the people, their ceremonies and games, their everyday implements and utensils.

The Cheyenne are one of the tribes of the Algonquian family; to-day they are divided into the Northern Cheyenne in Montana and the Southern in Oklahoma, and in 1921 they numbered about 3281. They call themselves Tsistsistas, which probably means "our people," "those related to us," though the Rev. R. Petter has suggested that it means "cut" or "gashed" people, from the sign by which they used to designate themselves. Their movements can be traced back for about 200 years, but the tales of their origin are, as G. A. Dorsey also says, rather tales of early migration than of origin. They seem to have come from the north-east or east, but from how far north it is impossible to discover, possibly from a region north of the great lakes and toward Hudson Bay, as their legends tell of crossing a great lake much in the manner of the Israelites under Moses.

The old-time lodges were made of willow shoots plastered over with clay for the winter, but in summer their lodges were woven of peeled and unpeeled willow stems arranged to make a pattern, and unplastered. Their present lodges are made of skins, probably developed from the wind-breaks of undressed hides on a framework of poles which they used to set up.

Among methods of self-torture described in the chapter on camp customs is one which seems to bear

certain resemblances to the hook-swinging formerly practised in some parts of India. Dorsey mentions the same form of torture as having been performed in 1903 in connexion with the Sun Dance, but Grinnell says that though it might be done at the time of the Medicine Lodge, it might be done at any time in fulfilment of a vow. Strips of skin were often removed as a sacrifice well-pleasing to the Great Medicine, or Great Spirit, thus leaving scars all over the body.

The Cheyenne are organised into ten groups or divisions, and from the testimony of several of the most aged men, Mr. Grinnell has gathered much evidence of exogamy. Descent was matrilineal, and on marriage a man went to live with his wife's group. If a man deserted his wife, she and her children were cared for by her own group. Each group had its own special ceremonies and taboos, but these old practices have now long passed out of use and cannot easily be reconstructed. So difficult is it that the author says that present-day investigation would lead to the conclusion that tribal descent is in the male line, while up to twenty or twenty-five years ago the old men all agreed that the children belonged to the mother's group. Detailed inquiry into more than fifty marriages of old people, however, resulted in establishing the fact that the man and woman had in all cases belonged to different groups.

The author draws a delightful picture of the home life of the Cheyenne, giving an account of the natural daily round from childhood to death.

The second volume is mainly concerned with the war customs and great ceremonies and dances of the Cheyenne. There are seven soldier bands, mostly named after some animal; but not every strong and able-bodied man is necessarily a member of one of these bands. These bands form a kind of standing army and enforce the commands of the chiefs. To each band belonged four young women, chosen from the best families in the camp. Their duty was to be present at the meetings of the band, to take part in the singing and dancing, and sometimes to do the cooking. It was an honourable position; but though it was looked on as a kind of profession, no girl was obliged to remain in the band against her will; she generally resigned on marriage, though sometimes a married woman was chosen. There was also a curious institution called Contraries, usually two or three Contraries in each tribe, who acted and spoke in the reverse or opposite way to that of common usage. They had serious duties to perform, and might not mix on equal or familiar terms with the rest of the tribe; each had to "walk by himself," lest those treading in his tracks should meet with evil results. One of the chief duties of a Contrary seems to have been to protect his tribe from thunder, and to do this he carried a peculiar form of bow called a thunder-bow. He could only be relieved of office if some one asked for his bow, or if he lost it by any accidental means.

There is also a Contrary Society, the members of which, though they seem to have no connexion with the Contrary warrior with the thunder-bow, also act by contraries and are in some way connected with thunder. The members are mostly old men and women, and appear to be buffoons, but at the same time they are believed to be able to help the sick. In the Massaum Ceremony (Crazy or Animal Dance), which is fully described, the Contrary Society plays the part of the hunters who pretend to kill the animals represented by other actors in the ceremony. This Massaum Ceremony is an ancient rite and seems originally to have been performed in order to increase the supply of food in the camps. It takes place when any man makes a vow to perform it in order to obtain some benefit for himself, but at the same time it benefits all the community. It lasts for five days.

A detailed account is also given of the Medicine Lodge, the midsummer or summer ceremony of many Plains Indians, which was fully described by G. A. Dorsey in 1905 in the Field Columbian Museum Publication 99, as a part of his studies on the Sun Dance of the various tribes. This term, however, comes from the Sioux, and refers to one part only of the Cheyenne ceremony, which now lasts three, but formerly eight, days. This ceremony, too, is offered as a sacrifice by one or more members of the community. It was at this ceremony that the self-torture often took place.

Though the Indians are repeatedly said to be very religious, there seems to be no official priesthood; but for these great ceremonies there are special "instructors," who take the part of priests or masters of ceremonies.

As may be seen from this résumé of some of the contents, the book is full of interest, and it is written in a simple straightforward style which makes the reader feel all the time that the subject is dealt with by one who is intimately acquainted with the matter in hand. It is a most valuable and sympathetic study of a people whose old customs are still in a measure retained, though obviously breaking down under modern conditions, and thus it is well to have these things recorded before more is forgotten. As it is, the author is frequently obliged to confess that in some cases the meaning of certain ceremonies appears to have been lost.

A. C. HADDON.

Our Bookshelf.

Wood-fibres of some Australian Timbers: Investigated in reference to their Prospective Value for Paper-pulp Production. By Richard T. Baker and Henry G. Smith. Pp. 159. (Sydney: Alfred J. Kent, 1924.) n.p.

DURING the War the Australian people suffered much inconvenience from the deficient supply and high price of paper and paper-making materials, which could be procured only by importation from Europe and North America. This directed attention to the possibilities of the manufacture of wood-pulp at a cheap rate in the Australian forests; and during recent years some investigations have been carried out by the different governments of the Commonwealth A short account of the nature and results of these inquiries is given in the introductory part of this book; and it is apparent that there is no lack of suitable kinds of timber. Sites for pulp mills can be found in certain forest districts where an abundance of pure water is available, an essential requirement for commercial success.

The main part of the work is devoted to a detailed study of sixty species of trees, as regards both the microscopic structure of the wood-fibres and the bleaching and felting properties of the separated fibrous material. Each description is accompanied by a photomicrographic illustration. Most of the species of Eucalyptus are of little value for paper-making owing to the shortness of their fibres; but the so-called "ashes," which constitute one section of this large genus, have long and flexible fibres, and are considered to be very promising for the production of "chemical" wood-pulp. The only conifer studied, *Araucaria Cunninghamii*, is suitable for the same purpose, and "sulphate" pulp is manufactured from it on a commercial scale at Yarraman Creek in Queensland.

The Control of the Speed and Power Factor of Induction Motors. By Dr. Miles Walker. Pp. 151. (London: Ernest Benn, Ltd., 1924.) 18*s.* 6*d.* net.

IN recent years the use of the three-phase system of distributing electric power has been rapidly extending. The great advances made in the methods of controlling economically the speed of induction motors are not known to many engineers. It is necessary, in order that they may choose the best kinds of motor for their every-day work both from the points of view of ease of control and of economy, that they should be able to study for themselves their relative advantages and disadvantages. We therefore welcome this book by one of the leading authorities on the subject.

In Chapter i. the author gives a sketch of the fundamental theory. He lays stress on the importance of the mathematical method of inversion as this leads to a simple method of proving the "circle" diagram. We are sorry that no proof is given of the geometrical theorems of inversion, as students may have difficulty in proving these for themselves.

A very full description is given of the methods of controlling the speed of an induction motor. In battleships two speeds are desired, one for cruising and one for "fighting." In the latter case the highest attainable speed is wanted. The fighting speed is usually about 50 per cent. greater than the cruising speed and requires about 3·5 times as much power. In the United States, where many ships have been fitted for electric propulsion, the method of pole changing is the one generally adopted. In the later chapters of the book, brief descriptions are given of the cascade motor and the frequency converter. A good description is given of the phase advancer designed by Gisbert Kapp.

Silent Highways of the Jungle: being the Adventures of an Explorer in the Andes and along the Upper Reaches of the Amazon. By G. M. Dyott. Second edition. Pp. 320 + 16 plates. (London: Chapman and Dodd, Ltd., 1924.) 7*s.* 6*d.* net.

THE interest of this book is more adventurous than scientific, but it is most readable and the pages are seldom dull. The author was commissioned by the Peruvian Government to investigate the possibility of aerial routes between the Pacific littoral and that isolated part of Peru which lies around the head streams of the Amazon. With this end in view, he made a journey overland from the port of Pacasmayo through the Andes by Cajamarca and Moyobamba to Yurimaguas and down the Huallaga and Marañon to Iquitos. This was a relatively easy task: the return by a more northern and partly unknown route was difficult. In the forests of the upper Marañon, Mr. Dyott was basely deserted by his carriers and left to his own resources in a trackless wilderness. At his last gasp he fell in with forest Indians, by whom he was held a virtual prisoner for some weeks before he got away and returned to the coast. The book describes vividly the conditions of travel in those remote regions, and has a good deal of information about rubber and agricultural possibilities, but its chief value lies in the account of the Aguavuna Indians. Existing maps were found to be faulty, but Mr. Dyott had no means of making new ones.

Physiotherapy Technic: a Manual of Applied Physics. By Dr. C. M. Sampson. Pp. 443. (London: H. Kimpton, 1923.) 30*s.* net.

MAJOR SAMPSON defines physiotherapy as "the use of physical remedies in the treatment of disease or disability," and classifies these remedies as thermal, chemical, mechanical, and electronic. Of the value of such methods of treatment there can be no doubt, but the author of "Physiotherapy Technic" has certainly not justified his claim that physiotherapy is destined to be the salvation of therapy. The main defect in this book is the very loose style of thinking and construction which it indicates. For the description of one technique we are referred to "Treatment of Optic Neuritis," but have failed to find the reference. The statement that "things not equal to the same thing are not equal to each other" is absurd, but its appearance as an argument in a scientific text-book is worse than absurd.

Major Sampson's experience entitles him to speak with authority on the methods of application of physical remedies, but the scientific reader will probably tire of the effort to discover what these methods are.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Sex Change and Breeding in the Native Oyster, *O. edulis.*

IN NATURE in 1922 (vol. 110, p. 212) it was shown that when an oyster spawns as a female it changes immediately into a male. In a later number of NATURE (vol. 110, p. 420) Spärck, who had been working on similar lines to the present writer, was able to confirm this observation. I have since continued similar observations on a large number of oysters with the same result, so that it can now be definitely stated as a fact that the female-functioning oyster normally changes into a male at about the period of the extrusion of ova; and further that the rapidity of the change strongly suggests the existence of a substance—which causes this change—in a fluid circulating in the body.

In the same number of NATURE I stated that experiments had been started to investigate the conditions of the reverse sex-change, that is, from male to female in both young and old oysters. The occurrence of this change has been suspected to occur on general grounds, but, so far as is known, has not been demonstrated. A brief summary of the results can now be given In the summer of 1922, 115 oysters, which were proved to be male on a certain date by microscopic examination after boring a hole in the shell, were isolated in a cage in the sea along with 78 identified females. This experiment was a failure owing to an accumulation of mud in the experimental cage, and was repeated in July 1923 with 101 freshly determined males, and 28 fresh females, along with the remainder of the oysters the sex of which was known in 1922. By October 1923 nearly all the oysters had recovered, and most of them had put on good growth, but a sample of 18 oysters, which were male in July, were proved after a thorough examination to be either mostly feebly male or neuter sex. None of the oysters were in spawn at this time.

In June and July this year the oysters were again examined, with the following result at the instant of examination: of the 6 remaining individuals which were male in 1922, 50 per cent. had changed to females, and two of these were carrying recently extruded embryos; of the 69 remaining individuals proved to be male in 1923, only two extruded embryos at the time of examination; the rest are being kept intact in the sea to permit periodical examination for later spawning females.

Besides these proved male oysters, others which have spawned as females—which, as has now been established, would have changed immediately afterwards into males—have been also kept isolated in compartments of a cage in the sea. Of 16 remaining individuals female in 1922—and therefore by inference afterwards immediately male — 5 were female in July 1924, and 1 was carrying embryos at the time of examination; similarly, of 20 oysters female in 1923, and immediately afterwards male, 6 had changed into females in July 1924, and of these 2 were carrying embryos at the instant of examination.

The experiments described above were carried out at West Mersea on the East Coast, but similar results have also been obtained on the River Yealm on the South Coast. In the Yealm experiment some interesting cases occurred; for example, an oyster male in July 1922 was examined on July 9, 1923, and found to be still male, but nearly seven weeks later, on August 31, this same oyster was carrying an enormous number of fully developed shelled larvæ, and a few days later, on September 4, was rapidly developing sperm. This is an extremely interesting and important result, both theoretically and economically. In the same cage were 18 oysters, which were obtained from different parts of England; these had spawned as females in 1923, and afterwards changed immediately to males; of this group, 3 extruded numerous embryos in June to July this year, and were found by microscopic examination to have changed back again to males at once. It is expected that some of the remainder will have embryos during the next few months. Thus already 11 per cent. of these oysters have had at least *four experiences of sex in about a year*, reckoning from July to July, and this is believed to be the normal sequence of events in the European oyster for a good proportion of individuals which assume female characters in spring or early summer. It is, however, still an unsolved problem what proportion of individuals which are male in the spring change during the summer into females. So far I have only obtained one such case, but the reason would appear to be found in the difficulties of the work. It has been shown elsewhere that too much handling of oysters in summer causes "bleeding," and a loss of condition (Orton, "Fishery Investigations," vi. 3, 1923 (1924)), so that it is necessary to work continuously on or in close proximity to good oyster beds to obtain good results. Efforts are now being made to fulfil these conditions in further work.

In all the observations recorded above, it is to be noted that sex-conditions are only determined at the instant of examination, and as it is clear that sex-change does occur very rapidly, some sex-changes may have been missed. It is believed that in many cases changes of sex have been missed.

In the breeding of the oyster there are phenomena of a confusing nature which can only be referred to briefly here. It has been found that the mere dredging of oysters in the breeding season will cause those females which are ripe to spawn. I have called this phenomenon "forced spawning," and it has some peculiar results. The spawning female may extrude the whole or indeed any proportion of its ova. Now there are good reasons for believing that the act of spawning initiates the internal changes which result in changing the sex to male, and undoubtedly the sex-change does occur in females which have undergone forced spawning without expelling all their eggs. As a result the gonad in such cases would appear to the uninitiated to be hermaphrodite. Such individuals are, however, physiological males, and it has been shown elsewhere (*loc. cit.*) that the "residual" ova, as they have been termed, are absorbed, or dealt with in other ways. There is nevertheless a small proportion of hermaphrodite oysters which cannot be explained satisfactorily as physiological males, and since the act of spawning as a female may cause or is closely associated with the causes of the change to maleness, it is possible that stimuli, other than spawning, may produce a like result in a ripening female, and so produce a true hermaphrodite gonad.

Other explanations are, of course, possible; but the *proximal* cause of the change from male to female is still to be found. The change to female occurs commonly in the winter or early afterwards, but we have seen that it does also occur in the summer, though to an unknown extent; it is therefore apparently independent of seasonal conditions. An explanation which would satisfy those conditions would appear

to be as follows: at the birth of an oyster the conditions which determine sex result at first in the establishment of a functional male gonad (this statement is apparently true, but must not yet be regarded as having been definitely proved); at some time later, generally at the end of the winter or even during the summer, the predominance of internal male-determining conditions is lost, and female characters are assumed. At this stage the position is clear, for immediately the female character is lost, namely at spawning, the sex potentiality swings back to predominant maleness. It has been seen that the male condition can occur twice in one summer, but we have no evidence yet of the occurrence of femaleness twice in one summer.

Even if we assume that specific hormones are responsible in predominance for the condition of maleness and femaleness respectively, yet it would appear that some factor connected with external conditions is the cause for the assumption of femaleness. Can this be merely the accumulation of reserve products in a quantity sufficient to produce a crop of ova reacting on the general system of the organism after the male-determining mechanism, so to say, has run down? This condition might be an excess of glycogen in the body over that amount which can be stored, for example. A fact which lends some support to this view is that starved oysters are either feebly male or of neither sex. It is at this point that the study of sex-change appears to touch the all-important problem—for oyster-culture—of the "fishing-up" or natural fattening of oysters, on which subject there is still a great deal of work to be done. The investigations have been made partly by means of a grant from the Royal Society, and will be described in full on completion of the work in the Journal of the Marine Biological Association.

J. H. ORTON.

Marine Biological Laboratory,
Plymouth, July 23.

Relation between Pressure Shift, Temperature Class, and Spectral Terms.

IN a letter to NATURE of June 21, p. 889, I have shown the existence of a numerical relation between the pressure displacements of the lines of the iron spectrum, the temperature class of the lines, and the magnitude of the spectral terms which originate those lines by combination. It now seems probable that this relation is not only valid for iron, but may be a more general relation. Unfortunately, the available measures of temperature and pressure effects are neither very numerous nor very extensive, so that the general validity of the relation cannot at present be fully demonstrated. In a few cases, however, the available measures suffice to show that the relation holds very accurately.

The most complete data at present available are those for titanium. King (*Astroph. J.*, 39, 145, 1914, and 59, 1924) has studied the temperature effect; different authors have investigated the displacements by pressure, the results of Gale and Adams being the most extensive (*Astroph. J.*, 35, 1, 1912); C. C. Kiess and H. K. Kiess (Journ. Opt. Soc. Amer., 8, 607, 1924) have studied the structure of the spectrum of the neutral atom, and given the absolute values of the terms which form a great number of multiplets (quintets and triplets). Following the plan adopted for iron, the mean values of pressure shifts (taken from Gale and Adams) for multiplets of titanium have been plotted in Fig. 1 against the mean values of the sum of the terms forming each multiplet. The curve thus obtained is quite regular, and similar to that for iron, so that the two may be approximately superposed by a simple translation. Unfortunately, it is only possible to follow the curve for titanium up to displacement 0·20 cm.$^{-1}$; those lines which have appropriate terms to give displacements between 0·20 and 0·50 cm.$^{-1}$ are out of the range observed. In the tables of Gale and Adams there are some lines which show displacements greater than 0·50 cm.$^{-1}$, but they are not classified in multiplets.

Very recently, Laporte (*Zeit. fur Phys.*, 23, 135, 1924) has made an estimate of the absolute values of the iron terms, giving 48,000 cm.$^{-1}$ for the term A, to which, in my first letter, the arbitrary value 60,000 cm.$^{-1}$ was assigned. In a future communication it will be shown that this value is a little too small. If the value 50,000 cm.$^{-1}$ be adopted, all the values of the remaining iron terms must be lowered by 10,000 cm.$^{-1}$, and the sum of two terms by 20,000 cm.$^{-1}$. When this correction is applied, the titanium curve superposes on the iron curve very closely, thus indicating that the relation for iron is not only of the same form for titanium, but also of the same order of magnitude.

The curves for iron and titanium show that the classification of lines in Classes I, II, . . ., may be

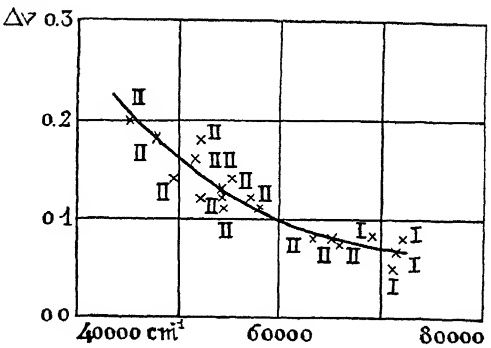


FIG. 1.

only a first approximation; the effect of temperature, like that of pressure, may be a continuous function of the sum of the terms. King remarks (*Astroph. J.*, 37, 264, 1913): "An examination of Table I (referring to the classification of iron lines) shows a considerable variety as to the rate of growth among lines placed in the same class." In order to prove that the effect of temperature is as indicated by the curves for titanium and iron, I have examined in some detail all the spectra which have been investigated for multiplets and for temperature effects. In all cases the assumption has been quite confirmed. The details will be given elsewhere, but meanwhile the following examples will illustrate this point.

In the neutral iron spectrum there are several multiplets of Class I. If we arrange them in a list beginning with the multiplet for which the sum of its terms has the greatest value, and ending with that for which the sum has the smallest value, it will be noticed that we have at the same time arranged the multiplets beginning with the most sensitive at low temperature, and ending with the less sensitive. The greatest value for the sum of the terms is given in iron by the intercombination multiplet AE, or $n^5_3 - n^7_3$ (incompletely given by Walters, but now completed) in Paschen's notation, formed by the most sensitive lines of the iron temperature classification λλ5110, 5166, 5169, 5204, 5225, 5247, 5250, 5255; these lines, however, do not appear in King's furnace at 1400° because the sensitiveness of the film used was very poor beyond the blue. The relation of intensity of this multiplet AE in the arc and in the

furnace at low temperature is 1/1·2; multiplet AH, which is situated in the middle part of the list of Class I multiplets, gives 1/1 for this relation, and multiplet AJ, which is near the end of the list, gives 1/0·2. So the sensitiveness of the multiplets at low temperature decreases gradually when the sum of the terms decreases.

It is interesting finally to remark that the iron intercombination multiplets AE, AZ, AX do not appear reversed in spite of their being the most sensitive groups of this spectrum and combinations of the ground level A. I think that it is not a particularity of the iron spectrum, but a general feature of all intercombination lines. The resonance lines of magnesium, calcium, strontium, barium, and manganese, which are also intercombinations, are not found reversed. The titanium resonance lines, which may be those of the intercombination multiplet $n^3_4 - n^5_3$ (λλ5397, 5409, 5426, 5447, 5461), because they give the greatest value for the sum of the terms in this spectrum, are also found to be very sensitive, but not reversed. M. A. CATALÁN.

Laboratorio de Investigaciones Físicas,
Madrid, July 1.

The Use of Naphthalene as a Fumigant in the Control of Red Spider and other Pests in Cucumber Houses.

A LETTER on "The Effect of Naphthalene Vapour on Red Spider Mite," signed by Mr. O. Owen and myself, appeared on pp. 280 and 281 (No. 2849, vol. 113) of NATURE on June 7.

Since that letter appeared, experiments have been carried out in distributing naphthalene in various states of division over the beds in cucumber houses. The state of division was determined simply by passing pure commercial white flake naphthalene through a graded series of sieves, ranging from 4 to 20 meshes to the inch, "milled" naphthalene has also been used.

With naphthalene which has been passed through a sieve of 16 meshes to the inch (=256 meshes to the square inch) all stages of the red spider mite (*Tetranychus telarius* L.), including the eggs, were killed in cucumber houses within a period of 24 hours, when the soil surface was at or above a temperature of 24° C. The amount of naphthalene used was 3 lb. to every 100 feet of bed. Similar results could only be obtained with naphthalene passed through a sieve of 8 meshes to the inch by using double the weight of naphthalene, while powdered or milled naphthalene did not kill all the spider, and tended to produce scorching of the plants.

Experiments have shown that very finely divided naphthalene volatilises too quickly, and that the large concentration of vapour resulting does not remain long enough in the atmosphere to kill all the mites. With milled naphthalene, on the other hand, the particles adhere so closely together that neither suitable distribution nor an adequate concentration of the vapours are obtainable.

When pure commercial white flake naphthalene was passed through a sieve of 16 meshes to the inch, and broadcasted by hand at the rate of 3 lb. to every 100 feet of border, no scorching of leaves or damage to plants resulted, provided that the plants were well watered before, and the atmosphere kept moist during fumigation. Plants lacking water, however, were often considerably scorched though not permanently injured.

During fumigation the fruit is liable to taste slightly of naphthalene, so that it is inadvisable to cut fruit until the odour of naphthalene has disappeared from houses treated. If exposed to fresh air, the taste soon leaves the cucumbers.

Other pests liable to destruction by naphthalene fumigation in cucumber houses are wood-lice (species of Porcellio, and Armadillidium) and crickets. The fumigation has now been carried out on the commercial scale for cucumbers, and has proved effective in houses and blocks of houses ranging from 50 to 200 feet in length, and from 8 to 20 feet in height. It was found unnecessary to increase the amount of naphthalene in the higher houses.

In all cases the red spider mite has been killed without damage to the plants, by one fumigation, and a large proportion of the wood-lice have at any rate been destroyed. EDWARD R. SPEYER.

Nursery and Market Garden Industries'
Development Society, Ltd.,
Experimental and Research Station,
Cheshunt, Herts, July 22.

Oscillations in Vacuum Tube Discharges.

A LETTER from Profs. Karl T. Compton and Carl H. Eckhart appears in NATURE of July 12, in which reference is made to experiments on oscillations occurring in vacuum tube discharges functioning with the aid of a hot cathode.

I should like to be allowed to point out that, so far as I am aware, the first published notice of this effect was a paper of mine in the *Radio Review* (now the *Wireless World and Radio Review*) of November 1919.

The general explanation there offered of the phenomenon requires some modification, but it was clearly shown that in the particular case of mercury vapour, ionic oscillations of easily regulated frequency could be produced by merely altering the potential conditions of the tube.

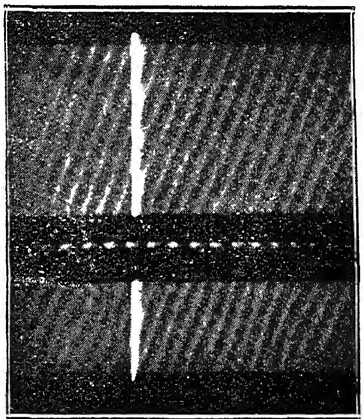


FIG. 1.

May I add that during the past year I have been following up these results in the particular case of vacuum tube discharges both with hot and cold cathodes with interesting results? When the discharge obtained from a battery of accumulators is viewed in a rotating mirror, cases are found when the appearance presented by the photograph (Fig. 1) is the rule. (See Aston and Kikuchi, Proc. Roy. Soc., 1921.)

The inclined lines represent flashes of luminosity proceeding at a constant velocity away from the cathode, apparently moving at a rate which depends both on the gas pressure and on the applied potential.

The spectrum when examined by the Fabry and Perot étalon method does not exhibit, however, the Doppler effect.

These and other results will be presented and discussed in a paper now in course of preparation.

R. WHIDDINGTON.

Physics Laboratories,
The University, Leeds,
July 16.

Absorption Spectra of Some Metallic Vapours.

In the course of our experiments on the absorption of light by vapours of different metals, we have recently photographed the absorption spectra of lead, bismuth, antimony, thallium, and magnesium with the following results :

(1) The absorption spectrum of lead shows at 1100° C., besides the fundamental line 2833 and some other lines, a faint banded spectrum which has not been described previously. These bands extend from λ3000 to λ3320 Å.U. The interval between the various bands is nearly constant and is equal to 32 Å.U.

(2) The absorption spectrum of bismuth shows besides the "raie ultime" 3067, a typical banded spectrum containing about twenty bands. The absorption at each of these bands is very diffuse and complex, consisting of a number of fine bands. With increase of vapour density all the bands gradually fuse together (beginning from the short wave-length side) to form a region of continuous absorption.

(3) The absorption spectrum of antimony shows a fine line and a banded spectrum on the short wave-length side of this line, which has not been described previously. The fine line is at λ2310, and the bands extend from λ2304 to λ2200, with a constant interval of 15 Å.U. nearly. Eight of these bands have been photographed.

(4) A long column of non-luminous vapour of magnesium is found to absorb, besides the line 2852, λ4571, the single line spectrum of the element.

(5) The absorption spectrum of the non-luminous vapour of thallium shows at high temperatures, besides the lines of sharp and diffuse series, some prominent bands and lines due probably to Tl_2 molecules. A study of anomalous dispersion of the vapour by the method of Kundt's crossed prisms showed that at λ3775 there is anomalous dispersion and that at 5350·6 the phenomenon is much weaker.

A detailed account of these experiments together with the photographs of the absorption spectra will be published shortly.

A. L. NARAYAN.
G. SUBRAHMANIAM.
D. GUNNAIYA.
K. RANGADHAMARAO.

Research Laboratories,
H.H. The Maharajah's College,
Vizianagaram.

The Theory of Hearing.

To the letters of Sir R. A. S. Paget and Mr. Wilkinson in NATURE of July 19 I will reply in regard to the piano experiment by saying that what a person hears is chiefly what he expects to hear. A conspicuous example is that of hearing the tones in whispered vowels. Every observer hears a different system. In the piano experiment I can hear fairly good vowels for *ah* and *oo* when sung; otherwise the result is vague. Yet in speech I hear every minute shading. I am quite in agreement with these gentlemen and most other writers in believing that the vowels are characterised by tones of definite pitch, but that is a matter that cannot be established by any such method.

The portamento piano experiment, however, furnishes a definite proof that the ear is not a resonating organ. When a tone is sung into the piano portamento *all* the strings vibrate more or less, and the result is a complete jangle. Exactly the same result would occur if the ear were a resonating organ. Much singing and *all* speech is portamento. If the basilar membrane acted by resonance, the voice of the singer would usually be a jangle with no pitch, and for the melody of speech we would have only a confused noise. This is exactly what I pointed out in my original letter to NATURE, April 22, 1922. The piano as a resonating organ responds to portamento singing by a perfect jangle. That the ear responds by a sensation of a clear rising or falling tone is a quite adequate proof that it does not possess a resonating organ. This ought to settle the matter for good from the physical point of view. To those of us who are accustomed to work with delicate human tissues the Helmholtz resonance theory is simply unthinkable.

The resonance theory is dead and there is no use in wasting time in trying to put life into it again. The deformation theory, as explained in NATURE for April 26, rests on distinct theses in strict accordance with anatomical and physiological facts, not one of which has been called in question.

E. W. SCRIPTURE.

University of Vienna.

Germanium and its Derivatives.

UNTIL recently, germanium was regarded as one of the rarest of metals, but recent discoveries of larger sources of its minerals lend interest to any possible applications of this element. Germanium dioxide is appreciably soluble in water and an aqueous solution of a concentration of one in 5000 has a marked inhibitory action on the growth of *Bacillus coli communis*.

So far little is known concerning the organic derivatives of germanium which we are now investigating (Chem. Soc. Trans., 1924, 125, 1261). With the aid of the Grignard reaction, germanium halides have furnished germanium tetraphenyl, germanium triphenyl bromide and oxide, and hexaphenyldigermane. Water-soluble organic derivatives of germanium have also been obtained which are now under examination in this laboratory.

G. T. MORGAN.
H. D. K. DREW.

The University,
Edgbaston, Birmingham, July 18.

Mathematics at British Universities.

A LITTLE time ago I turned light-heartedly to the study of relativity. I had no doubt of the sufficiency of my equipment for such study because two British universities had found me worthy of a degree in mathematics. You can imagine my surprise when I found how little connexion the mathematics of relativity had with my university studies, and what a serious study of new subjects I must undertake. Chief among the new subjects is vector analysis or tensor calculus, and I am puzzled that so many continental writers (as well as a few in this country) show a command of vector analysis, while my two universities knew nothing of it.

It is, however, some years since I left these universities, and it may be that vector analysis has now attained an appropriate position there. It is on this point that I hope your readers may help me by telling me which universities include vector analysis in their courses, and by indicating how far they go in this and other subjects preparatory to relativity. In this inquiry I am not actuated by mere curiosity. I am anxious to know, and I am sure many of your readers also wish to know, whether the teaching of mathematics in our universities is abreast of the times I hope, therefore, that some one at Cambridge will say what is being done there, or if Cambridge is doing nothing, I hope some one elsewhere will be able to show that his university is making good the omission of Cambridge.

A BEGINNER IN RELATIVITY.

Surveys from the Air: the Present Position.[1]

THE issue by the War Office of the first Report of the Air Survey Committee affords an opportunity of reviewing the progress made in this method of making maps; more especially because the excellent Report in question puts together, in a comparatively small book, a mass of information not easily accessible elsewhere, and is written by the authority of the War Office, the Air Ministry, and the Ordnance Survey.

In discussing the matter it is very desirable to bear in mind that the object in view is the construction of an *accurate* map. It is this factor of accuracy which creates most of the difficulties found in practice. Indeed, if we are content with a pictorial representation of the ground, or with a sketch of uncertain trustworthiness, there is no problem—the thing is already done. It is when we try to produce, by this method, a map of the same high degree of correctness that we expect from a modern ground survey that we find that there are many obstacles to be overcome.

Owing to the special conditions that obtained on the Western Front during the War, the difficulties of the method were very commonly underrated. In this area there were available the old cadastral plans of France, discontinuous and some eighty years out-of-date, but still showing correctly the features which survived. The problem in this case was to correct an out-of-date map of which there existed a trigonometrical frame work. Moreover, along the British portion of the line the ground was generally flat, or only gently undulating, a circumstance which made the conversion of an air-photograph into a plan much easier than it would otherwise have been. The Committee reports that "an undue optimism as to the ease, cost, and suitability of air photo-topography was common at the close of the War."

Broadly speaking, we may tackle the problem in two ways. Either we may take the photograph of the ground without any special precautions as to the axis of the camera being vertical, and without attempting to ascertain its height above the ground. We must then, in the ordinary case, rely upon a fairly close network of measured points on the ground, and from the positions of their representations on the photograph we can, in several ways, determine the tilt, and direction of tilt, of the camera, and its height at the moment of exposure; or we may take precautions to fly level and straight at a known height.

The latter system has been carefully studied at Cambridge by Prof. Melvill Jones; and it is to him and to Major J. C. Griffiths that we owe its present development. It appears that "when the pilot is flying in fair weather at a height sufficient to escape surface air pockets, the probable errors of tilt and difference of flying height have been reduced to 1° and 40 ft. respectively." Truly remarkable results. When it is considered that during the War the average tilt was of the order of 10°, it will be seen what excellent progress has been accomplished in this direction. But still, straight and level flying only solves the difficulties in special cases. When there are considerable differences of level in the terrain photographed, large errors will appear on the resulting map. Where any approach to accuracy is desired, the system of making a map from an uncorrected "mosaic" of photographs taken in this way can be applied only to level areas. But probably it can be effectively applied to the surveys of estuaries and deltas and perhaps to the mapping of large native towns, which in most cases are scarcely worth accurate large-scale ground surveys. Sometimes in war the use of uncorrected mosaics may be inevitable; but that is scarcely the question before us.

In the general case, what is required is the means of mapping hilly and undulating country at a cost which will compare favourably with that of modern ground surveys. It may be as well to state at once that this state of affairs has not nearly been reached. It looks, in fact, as if it would be a long time yet before it is reached. Much patient work is still necessary, though it is only fair to say that much has been done. Experimenters are feeling their way, and are as yet unable to decide which of many promising paths is most likely to lead to the desired goal.

Apart from the use of uncorrected "mosaics" there are two principal problems to be solved. The first is to map, by means of air-photographs, a hilly district which has been so well provided with a framework of fixed points that, in general, four of these, well distributed, will be found on each photograph. The second problem is how to survey with accuracy, from air-photographs, a limited region or gap between two surveyed areas, the region in question not being provided with any fixed points. It is not to be assumed in either problem that it is possible to arrange for the axis of the camera to be vertical; and in each problem we must take account of the hilly character of the ground, and attempt to contour it.

It may be taken for granted that the focal length of the lens is known and also the position of the optical centre of the plate. Now if, in addition, we could find the amount of the tilt and the direction of the tilt, the problem would be much simplified. The Committee, therefore, turned its attention to the determination of the tilt by means of a gyroscopic apparatus, and it is reported that during approximately straight flight the apparatus worked well and that an accuracy of one-quarter of a degree might be expected.

An alternative method of finding the tilt is to make use of a "tilt-finder," a machine devised by Major MacLeod, which reproduces, in miniature, the conditions which obtained in the field (Fig. 1). To use this machine it is necessary to know the focal length and optical centre, and to have available the positions of three ground points, which in the latest model need not be of the same height. Three planes are dealt with: namely, the ground plane P′, which need not be horizontal; the map-plane M, which must be horizontal; and the photo-plane P, of which it is desired to ascertain the tilt. By a succession of approximations it is possible to determine the tilt with a satisfactory degree of accuracy.

If the terrain to be surveyed is flat, or nearly so, and if four points of which the co-ordinates are known are shown on the photograph, then it is possible to cover the map with a rectilinear grid, and by a graphic construction to draw the representation of this grid on

[1] Report of the Air Survey Committee. No. 1, 1923. Pp. 131. (London H M. Stationery Office, n d) 4s. 6d. net

the photograph (Figs. 2 and 3). The photo-grid will be composed of two sets of straight but converging

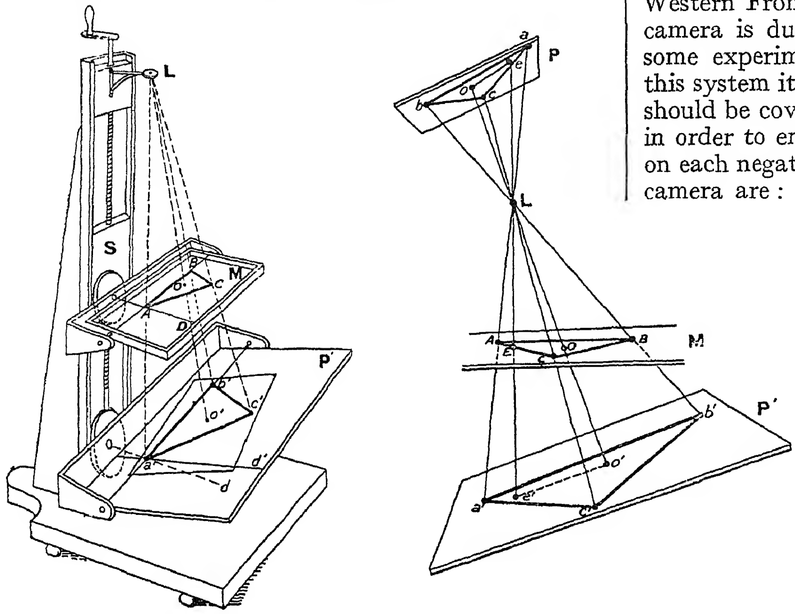


FIG. 1.—The tilt-finder (Mark I). Reproduced by permission of the Controller of H.M. Stationery Office, from the Report of the Air Survey Committee, No. 1, 1923.

lines. If the grid is close enough, the detail can be drawn in on the map without difficulty.

The problem is, of course, capable of mathematical treatment. If there are given the focal length and at least three known points, it is possible to determine the position of the camera in the air and the constants of the plate. Where the ground is approximately level the mathematical treatment is easy; but in hilly country it becomes cumbrous—and expensive.

In hilly country, for the purpose of plotting the relief, it is useful to employ oblique photographs, in addition to those taken with the plates horizontal. If the "obliques" are taken at lower altitudes than the horizontal plates, they can be at high tilts and are then most valuable. This may involve, however, the uneconomical procedure of double flights. Generally, the more the plate is tilted the more valuable it is for determining the relief and the less valuable for planimetry.

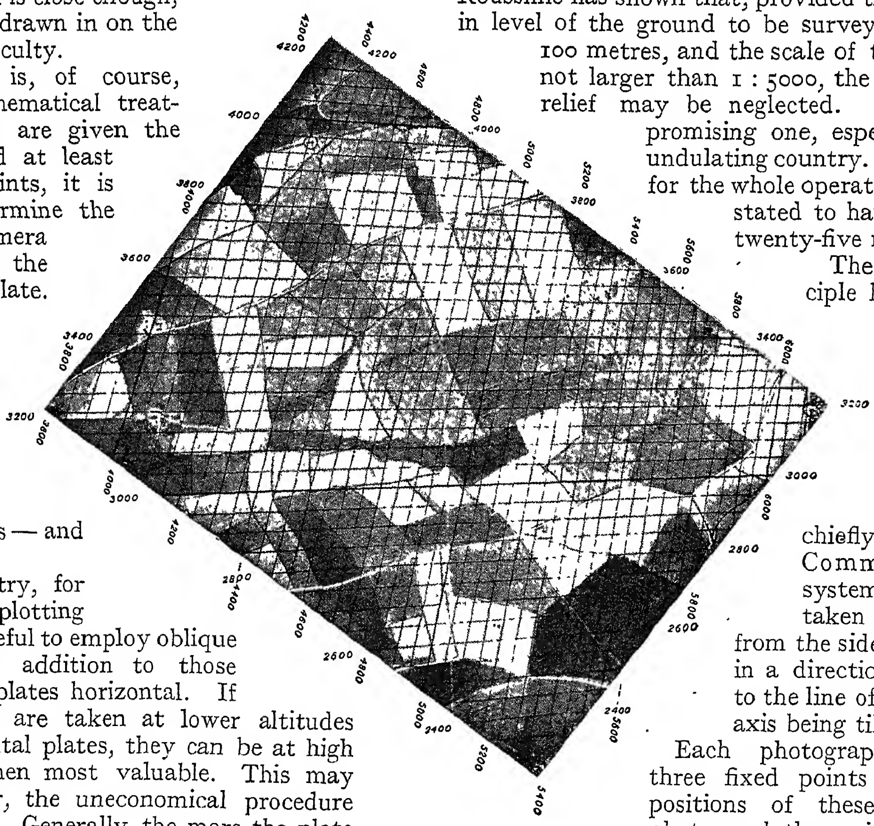


FIG. 2.—The photo-grid. Reproduced, by permission of the Controller of H.M. Stationery Office, from the Report of the Air Survey Committee, No. 1, 1923.

The rectification of the air-photograph can also be accomplished photographically. This method was, in fact, in use by the British and French armies on the Western Front. An up-to-date form of the rectifying camera is due to M. Roussilhe, who has undertaken some experiments for speed, cost, and accuracy. In this system it is necessary that the area to be surveyed should be covered with a close network of fixed points in order to ensure that three fixed points shall appear on each negative. The essential parts of the rectifying camera are: a projecting lantern, a negative-carrier, a lens-carrier, and a screen-carrier. The carriers are all capable of horizontal movement and of rotation. A tracing or diagram of the three control points, plotted to scale, is fixed to the screen-carrier, and the apparatus is manipulated until the projected images of the three control points in the negative correspond with the three points on the screen-carrier. If the three points are not all in the plane of reference a second adjustment will be necessary. The adjustment having been made, the tilt can be found to within ½ degree, the position of the map plumb-point to within 10 metres, and the height to within 10 metres; the rectified print is the required map, to scale. M. Roussilhe has shown that, provided that the differences in level of the ground to be surveyed do not exceed 100 metres, and the scale of the photograph is not larger than 1 : 5000, the distortion due to relief may be neglected. The method is a promising one, especially for flat or undulating country. The time required for the whole operation for one plate is stated to have been reduced to twenty-five minutes.

The stereoscopic principle has also been applied to air photo-surveying, and may be exemplified by the system evolved by Prof. Hugershoff, which is that chiefly dealt with by the Committee. In this system, photographs are taken in pairs, by hand, from the side of the aeroplane, in a direction at right angles to the line of flight, the optical axis being tilted to about 60°. Each photograph must include three fixed points; and from the positions of these points on the photograph the position of the camera in space is measured, and the direction of the optical axis. Each pair of photographs is then placed in the autocartograph, which is, in principle, much the same as the stereoautograph

of Von Orel. By means of the autocartograph the map can be plotted mechanically; and by clamping the height lever at a particular height, and keeping the stereoscopic pointer (in appearance) just in contact with the ground, a contour can be traced. The whole apparatus is elaborate and expensive, and it would need many pages to describe it at all adequately. It has possibly come to stay, though it has not yet been subjected to exhaustive tests. The stereoscopic method has the great advantage that it is possible by its means to draw the contours of a bare hillside, an impossibility with any point-by-point system; and this requirement of drawing contours must be met if air photo-surveying is to have any general application to topography. A topographical map of the normal type shows the ground features by approximate contours, which are controlled by a trigonometrical framework. At present, apart from the stereoscopic methods above mentioned, air photo-surveying is incapable of supplying the contours in open country. It is therefore, at present, only fitted for the survey of flat countries. It would be waste of time and money to prepare a ground plan by air methods and then go over the same ground again for the survey of the contours.

The position that has been reached is briefly this: Air photo-surveying is indispensable in war. In peace-time it has a unique field of usefulness for archæological purposes; for it has been shown by Colonel Beazeley, Mr. O. G. S. Crawford, and others, that air photographs may show ancient features that are invisible except from the air. For surveying purposes air photographs are probably, even now, of value for the mapping of estuaries and deltas, and possibly for the mapping of native towns on medium scales. It also appears likely that in flat or very gently undulating country the method can be used for the construction of cadastral plans without contours, with satisfactory speed and accuracy; and that in such circumstances the cost may be brought down to a practicable figure.

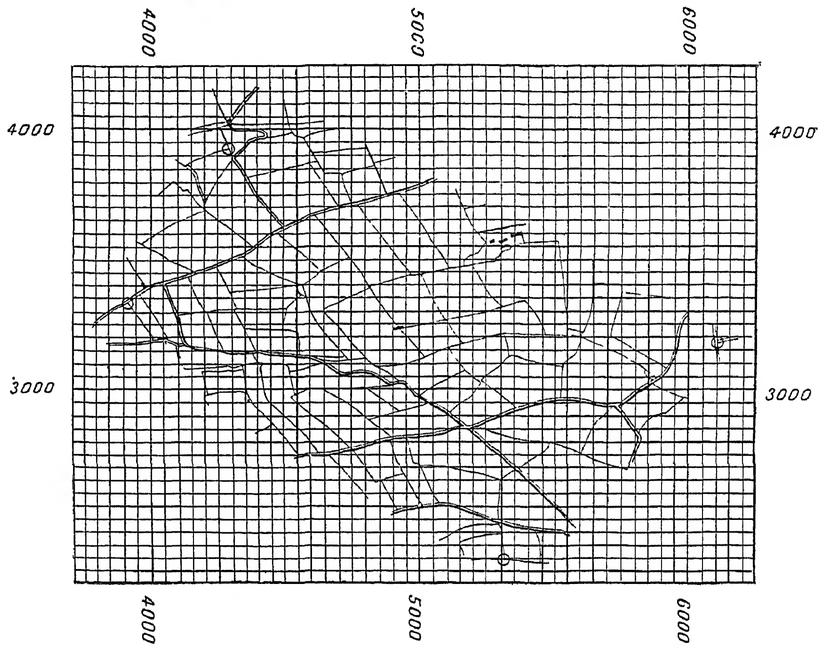


FIG. 3.—The map-grid Reproduced, by permission of the Controller of H.M. Stationery Office, from the Report of the Air Survey Committee, No. 1, 1923.

But at present, for the construction of contoured topographical maps, air photographs cannot be economically employed; and the same remark applies to the construction of maps and plans, on all scales, for all purposes, in hilly country. The future use of air photographs, so far as concerns the general peace-time application of the method to the construction of accurate topographical maps, would appear to lie in the development of stereoscopic methods.

Any one interested in the subject may be advised to purchase the Report of the Air Survey Committee, which is clearly written, well illustrated, and contains much useful information, including a short bibliography.

C. F. CLOSE.

The Reported Transmutation of Mercury into Gold.

IN NATURE of March 29 last (pp. 459-460) we printed a communication by H. Nagaoka, Y. Sugiura, and T. Mishima "on the isotopes of mercury and bismuth revealed in the satellites of their spectral lines," at the end of which the authors stated that "if the above assumption as to the mercury nucleus is valid, we can perhaps realise the dream of alchemists by striking out a hydrogen-proton from the nucleus by α-rays, or by some other powerful methods of disruption." Following this statement, on July 21 the *Morning Post* reported from Berlin that Dr. A. Miethe, professor of photochemistry and astronomy in the Technical High School at Charlottenburg, had obtained gold from mercury by the prolonged action of a high-tension electric current upon it. In the absence of details, such a report could only be received with great reserve, for in the light of existing knowledge it seemed highly improbable that the amount of energy indicated to have been used would be sufficient to disrupt the mercury atom. An account of Prof. Miethe's work containing some definite experimental details is given in the issue of *Die Naturwissenschaften* for July 18, and we reproduce these in order that the claim advanced may be justly assessed.

Some thirteen months ago, Prof. Miethe adopted an improved type of mercury-vapour lamp, made by A. Jaenicke, for his experiments on the coloration of transparent minerals and glasses induced by ultra-violet rays. Early this year, he and his assistant, Dr. H. Stammreich, observed that when the current employed was too strong, the character of the emitted rays soon changed, and that a black deposit formed inside the lamp. (It is not stated if the lamp was of quartz or of glass.) This observation was confirmed by Jaenicke, who stated that on distilling the mercury recovered from old lamps of the improved type, he had

found residues which he could not identify. He supplied Prof. Miethe with about 0·5 gram of the residues (which had been obtained from 5 kg. of mercury), and the latter after careful investigation discovered that they contained gold, in addition to other substances which were undoubtedly present as impurities in the original mercury. According to Jaenicke, all the mercury used in the lamps had been twice distilled before use. In his successful experiments, Prof. Miethe always used a potential difference of 170 volts between the electrodes, which were in direct communication with the air outside; the current was passed for 20-200 hours; and the lamp consumed 400-2000 watts. It appeared probable that a minimum P.D. is essential, for no trace of gold was found in mercury lamps of the old type that had been long in use, and negative results were also obtained with lamps of the improved type when the P.D. was below a certain figure.

Owing to the minute quantity of gold obtained, namely, 0·1–0·01 mg., special precautions had to be taken in identifying it. In every test an amount of the original mercury equal to that which was removed from the lamp was analysed and found to be free from gold both by Prof. Miethe himself and independently by K. A. Hofmann; and it was proved that no gold was present in the electrical connexions. Further, the very delicate analytical methods elaborated by Haber failed to show with certainty the pre-existence of gold. When the residue left, after distilling off *in vacuo* the mercury from the black deposit, was treated with nitric acid, there remained yellow well-formed crystals, cubical and octahedral in form, and with a highly reflecting surface; and when the mercury was removed from the deposit by volatilising it at a red heat, the resulting substance was bright gold in colour and of reniform or botryoidal shape. The substance was found to be malleable, it gave the streak of fine gold and the characteristic colour when the polished film was observed by doubly reflected light. It was easily soluble in aqua regia, and on evaporation the solution gave crystals precisely similar to those obtained when ordinary gold is so treated. Identical results were also obtained by the purple-of-Cassius test. It was not possible to make an atomic-weight determination or to attempt to prove the production of helium, hydrogen, α- or β-rays.

Obituary.

Sir James J. Dobbie, F.R.S.

JAMES JOHNSTON DOBBIE, whose death occurred at Fairlie, Ayrshire, on June 19, was born at Glasgow in 1852. He was educated at the High School of Glasgow, and entered the University of Glasgow, where he took his Arts degree with first-class honours in Natural Science. Later he worked at Leipzig in the laboratory of Wislicenus. There being no science degree at Glasgow in those days, he went to Edinburgh, and graduated as B.Sc., proceeding later to the Doctor's degree. He was elected to a Clark Fellowship at Glasgow University, and returned there and taught the class of mineralogy.

Sometime before this Dobbie had made the acquaintance of Ramsay, then a young assistant in the chemistry department of the university. Ramsay first introduced him to organic chemistry, and they read together Schorlemmer's well-known "Chemistry of the Carbon Compounds." Ramsay invited him to join in an investigation on the constitution of quinine, scarcely anything being known of the constitution of the alkaloids at that time. By oxidation with alkaline permanganate they obtained pyridine tri-carboxylic acids, which they identified, thus establishing for the first time the connexion between the alkaloids and the pyridine bases.

Soon after this Ramsay was elected to the chair of chemistry at Bristol, and Dobbie succeeded him at Glasgow. Here he continued his work on alkaloids, and also took an active share in establishing the Glasgow and West of Scotland Section of the Society of Chemical Industry, of which he was the first secretary.

In 1884 Dobbie was elected to the chair of chemistry in the newly founded University College of North Wales at Bangor. His first work was to get laboratories built and equipped, and to organise the teaching of his department. He resumed his research work on alkaloids, and made, in particular, a very complete investigation of the alkaloids of *Corydalis cava*, working out the constitution of corydaline and investigating also the structure of the associated alkaloids. This work, necessarily complicated, was rendered still more difficult by the high cost of the alkaloids, so that the investigation had to be carried out with very small quantities of material: the results were communicated in a series of papers to the Chemical Society from 1892 to 1904. A little later he took up the study of the relation between the ultra-violet absorption spectra and the constitution of organic compounds, working at first with the late Sir W. N. Hartley, and later with other workers. In particular, they showed how the method could be applied to determine the constitution of tautomeric bodies.

Dobbie's work at Bangor, however, was by no means limited to that of his own department. He felt that, in an agricultural country such as North Wales, one of the proper functions of the college was to do everything possible to promote its chief local industry. He spent several vacations on the Continent studying methods of agricultural education, and started a campaign for the founding of an agricultural department at Bangor. Funds had to be collected and the interest of the land-owning classes and the farmers, as well as that of the Board of Agriculture, aroused. After several years of strenuous work the agricultural department was at length inaugurated in 1894. Courses were provided leading to a diploma and later to a degree in agriculture, while a comprehensive scheme of extension lectures and experiments was devised. This was the first agricultural department to be founded in connexion with a University College, and it is impossible to overrate the importance of Dobbie's pioneer work at Bangor in the development of agricultural education. He took a leading part in the work of the foundation of the University of Wales, and the college and the university owed much in these early days to his sane judgment and great administrative skill.

In 1903 Dobbie was offered and accepted the post of director of the Royal Scottish Museum in Edinburgh, but gave up his work at Bangor with considerable reluctance. His wide interests and scholarship combined with his administrative ability made him an excellent director. He threw himself into the work of the Museum with characteristic energy, and greatly extended the collection of Egyptian antiquities, a subject in which he was much interested. He also collected funds to acquire for the Museum the valuable Noel Paton collection of armour and antiquities, and greatly developed the technical collections. He did not, however, relinquish his connexion with chemistry, but continued his research work, a regular series of papers being contributed to the Chemical Society on absorption spectra and alkaloid work.

In 1909 Dobbie was appointed principal of the Government Laboratory in succession to Sir T. E. Thorpe, and was at once required to undertake the reorganisation of the laboratory. This was made a separate Crown Department in 1911, dealing with chemical matters arising from all Departments of State, and Dobbie was the first to hold the position of Government Chemist. Here he continued his investigations in absorption spectra and on the alkaloids. His tenure of office covered the difficult years of the War, when the strain on his department was great. He served on various commissions and committees, and in particular his services on the Royal Commission on Rewards to Inventors, the Universities Grants Committee, and the Nitrogen Products Committee may be specially mentioned. He also acted for fourteen years as adviser on the research schemes in physics and chemistry to the Carnegie Trust for the Universities of Scotland.

Dobbie was elected a fellow of the Royal Society in 1904, and in 1915 his services to science, both as an investigator and as administrator, were recognised by the King, who conferred the honour of knighthood upon him. He received the degree of LL.D. from the University of Glasgow in 1908, and that of D.Sc. from the University of Wales in 1920. He was elected president of the Institute of Chemistry in 1915, and of the Chemical Society in 1919.

The foregoing is a bare outline of a life of varied and fruitful activity. In an unusual degree Dobbie combined the patience and lucidity of the born teacher, the fertility of ideas and resourcefulness of the research worker, and the clear common sense, critical yet always constructive, of the wise administrator. In addition to all these he had much of the scholar's temperament. Reading widely, but never without fine discrimination, he was indeed the "full man" of Bacon's aphorism, and his mind was a storehouse of information over a wide range of literature and history. To the end of his days the classics were his constant solace and relaxation, and he was a living negation of the supposed antipathy between science and the humanities.

Beloved by his students and fellow-workers, in the lives of his intimate friends he leaves a blank that can never be filled. He is survived by Lady Dobbie, one son, and two daughters.

ALEX. LAUDER.

WE regret to announce the following deaths:

Sir George Beilby, F.R.S., distinguished by his work in industrial chemistry, fuel technology, and many other departments of pure and applied science, on August 1, in his seventy-fourth year of age.

Dr. R S Woodward, president of the Carnegie Institution from 1905 to 1920, and formerly professor of physics in Columbia University, on June 29, at seventy-five years of age.

Current Topics and Events.

THE Toronto meeting of the British Association opened on Wednesday evening with the delivery by Sir David Bruce of his presidential address on the prevention of disease, which is printed in full in this week's Supplement to NATURE, together with abstracts of most of the addresses of presidents of Sections. The provisional programmes of the Sections were described in our issue of July 26, and articles upon the main subjects discussed will appear in our columns later. At the inaugural meeting, the following congratulatory message from H.R.H. the Prince of Wales was read: "Dear Mr. President, Will you be good enough to convey to the members of the British Association at their inaugural meeting in Toronto my cordial good wishes for a very successful session? My knowledge of Canada assures me that your visit will be warmly welcomed, and that nothing but good can come of such a gathering, where the representatives of the most advanced thought from the Old Country will meet in discussion the equally keen and active intellects of the Younger Land. My interest has been particularly arrested by one item that is to come up for discussion, namely, the educational training of boys and girls in this country for life overseas. The call of the Empire for a wider distribution of the home population, for men and women to open up the vast uncultivated areas in the great Overseas Dominions, is more imperative to-day than at any time in its history. I congratulate the Association on thus showing in its deliberations such a broad interest in these problems, and I trust, and indeed am confident, that the influence thus exercised may result in great and extended benefits to the Empire."

A STRIKING illustration of the attitude of Parliament and the heads of State departments towards scientific workers is afforded by an examination of the personnel of the committee appointed by the President of the Board of Trade "to inquire into and report upon the conditions and prospects of British industry and commerce, with special reference to the export trade, and to make recommendations with regard thereto." The appointment of this committee is the outcome of representations made by Sir A. Shirley Benn on May 21 in the House of Commons. On that occasion Major A. G. Church directed attention to the fact that the proposal not to include on the committee a representative scientific worker—other than economists—suggested that the House

did not realise that the greater part of the export trade of Great Britain was based upon the application of scientific discoveries. The function of the highly qualified scientific worker or technician engaged in industry is to improve industrial processes, to develop new processes, and, most important of all, to create new industries. Any national inquiry into trade must, therefore, necessarily consider the methods by which practical applications of science may be profitably encouraged. In the memorandum furnished to the Committee of Inquiry, upon which workers in science and technology are not represented, Mr. Sidney Webb states that it is their duty to make "an inquiry into British productive capacity and organisation . . . the present and future adequacy of raw materials and possible improvements in their utilisation, and the part played by the United Kingdom in new developments of industry, particularly those which are the outcome of scientific research." How such an inquiry is to be made on satisfactory lines without the assistance of those who possess a knowledge of science and its possibilities is difficult to understand. It is not enough to call scientific workers to give expert evidence; they should be given representation on the committee and share to the full responsibility for the report to be produced.

THE appointment of the Rev. Canon E. W. Barnes, F.R.S., Canon of Westminster, to the Bishopric of Birmingham, is a noteworthy sign of the times. Canon Barnes is a distinguished mathematician with wide scientific knowledge as well as a leader in theological thought, so that he represents the progressive spirit of both science and religion and combines the principles of truth and righteousness for which each should stand. In the early fifties of the last century, Robert Braithwaite Batty, second wrangler and first Smith's prizeman, gave up his promising career in England to preach the gospel, as then understood by the "evangelical" school of theology, to the natives of India. His humble missionary effort, contrary to medical advice, was closed by his death in a year's time. Canon Barnes, also second wrangler and first Smith's prizeman, is now nominate Bishop of Birmingham. The contrast is indeed strange and marks a new stage in the evolution of spiritual thought.

SIR MAX MUSPRATT, Bart., in addressing the eighth annual general meeting of the Association of British Chemical Manufacturers on July 17, said that great strides have been made recently in effecting co-operation among manufacturers and others associated with chemical industry, notably in the organisation of the chemical exhibits at the British Empire Exhibition. These exhibits have not only been instructive to students, but they have also been the means of bringing home to politicians and the public the importance of chemistry to the nation. There is considerable conflict of opinion within the Association concerning our dyestuffs policy: the council is trying to keep a balance between the opposing interests, and is advocating what it considers best for the Association as a whole. In supporting the principle of the Consolidated Factories Bill, the council approves of any measures that will make employment in factories easier and more pleasant, but it disapproves of hard and fast regulations that are unnecessary, or costly, or Utopian. Sir Max Muspratt is not hopeful that much can come out of the Rating of Machinery Bill, yet he hopes that the inquiries now being made into the general principles of rating will result ultimately in equitable treatment for chemical undertakings: the projected Census of Production will, if properly carried out, aid greatly in solving problems of unemployment, health, taxation, and rating. Sir John Brunner, Bart., referred to the Chemical Engineering Department of University College, London, and said that, although many hold that such education can produce only half-baked engineers and half-baked chemists, he thinks that there are many places in our Empire where large staffs cannot be afforded and where men trained in a chemical-engineering department could take control, if not of chemical works proper, of works in which chemistry plays a very prominent part, for example, in sugar factories.

WITH reference to our paragraph of July 19, p. 96, on the subject of trichlorophenylmethyliodosalicylic acid, it appears that this substance is to be classed among those actively germicidal owing to their inherent properties, rather than amongst those which owe their antiseptic powers to their ability to set free chlorine. The compound is very stable and its solution in water can be boiled without undergoing decomposition: it retains a great part of its germicidal action in serum. Used as an antiseptic in a 1 per cent. solution or less, it appears to owe its power to two distinct modes of action; on the one hand it stimulates the leucocytes, and thus aids the body's own defensive processes: on the other, it combines with the proteins of the bacteria by virtue of its chlorine groups; this combination is presumably with the amino-groups of the protein molecules. In this way it is attached to the micro-organisms and hinders or abolishes their activity; the phenyl and iodine radicles as well as the salicylic acid are themselves antiseptic of varying potency, and it is probable that with the attachment of the compound to the bacterial protoplasm by means of the chlorine group, the other groups are enabled to exert their action under more favourable conditions. Analgesic properties are also ascribed to it, owing to the fact that the chlorine groups are attached to the benzene nucleus. Finally, it is claimed by Dr. Callimachi that it shows little affinity for the protein molecules of human tissues, while reacting selectively with those of bacteria.

THE International Congress of Architects concluded a week's programme in London on August 2. Organised by the Royal Institute of British Architects, the meeting had for its object the discussion of architectural education, which is controlled in Britain and the Dominions by the examinations of the Royal Institute's education board. To reach the status necessary for the successful design and supervision of modern buildings requires a course of study not

less lengthy or exacting than that required for other professions, and the requisite training is provided in architectural schools, which usually give a four years' course, during which design, construction, and the technical and legal aspects of an architect's work are the subject of study. Discussions on three successive days were centred around architectural education of the past, present, and future, under the respective chairmanships of Lord Crawford, Sir Reginald Blomfield, and Mr. Cass Gilbert (U.S A.). In addition to a display of rare architectural books, a unique collection of students' drawings from all countries, large enough to require both Grosvenor House and Devonshire House for its accommodation, was exhibited. This is the first international meeting of architects held, and in addition to Britain and the Dominions, thirteen other countries were represented. While British schools are to be congratulated on their work, it must be confessed that the drawings of foreign countries, especially those of the United States, must be given the first place for boldness in conception and possibly also for skill in composition.

THE meetings of the British Pharmaceutical Conference were held at Bath on July 22-24. At the opening session the Mayor of Bath welcomed the conference to the city, and the chairman, Mr. Edmund White, delivered an address entitled "Pharmacy: Present and Future." He first directed attention to the changes which are gradually taking place in the practice of pharmacy as the result of changes in medical practice. The *materia medica* has been enriched by the addition of a large number of synthetic substances and animal products such as gland extracts, sera, and vaccines. Pharmacists should be trained to deal with these new developments and also to undertake the newer methods of laboratory diagnosis for the assistance of the medical practitioner. Mr. White then reviewed the work of the Consultative Council on Medical and Allied Services set up by the Ministry of Health, and, from consideration of the report of that body, concluded that much of the work of the clinical laboratories, which it is proposed to set up, could be done by pharmacists. As to the Therapeutic Substances Bill, he thought that the Pharmaceutical Society should take an active part in the examination and standardisation of remedies by physiological and biological methods. The twenty-three papers read at the science meetings included: a number of communications on bismuth compounds from the Research Laboratories of the Pharmaceutical Society, a study of Benedict's method for the estimation of glucose; the preservation of anæsthetic ether; carbon tetrachloride for medicinal purposes; assay of mercurials in ointments; and papers dealing with the following drugs: tragacanth, acetannin, valerian, erythrophleum, artemisia, nux vomica, *Strychnos cinnamomifolia*, and tannin-containing drugs. The delegates from branches of the Pharmaceutical Society met under the presidency of Mr. F. Pilkington Sargeant and discussed the control of pharmaceutical specialities; also articles of pupilage, and pharmaceutical service in the Army. The programme of social events included the Civic Reception, a banquet, concerts, and motor excursions in the beautiful country surrounding the city of Bath.

THE Council of the Royal Meteorological Society has awarded the Howard prize for 1924 to Cadet J. M. Goode of H.M.S. *Worcester* for the best essay on "Monsoons." The prize was competed for by cadets from the following institutions: H.M.S. *Worcester*, H.M.S. *Conway*, and the Nautical College, Pangbourne. The prize was presented to the successful cadet at the annual prize-giving on the *Worcester* on July 31.

PROF. J. C. FIELDS informs us that the following conferences are to be held at the International Mathematical Congress at Toronto on August 11-16: "Some of the Characteristic Features of Twentieth Century Pure Mathematical Research," Prof. W. H. Young; "Science and Engineering," Sir Charles Parsons; "Modern Norwegian Researches on the Aurora Borealis," Prof. Carl Stormer; "Solved and Unsolved Problems in Dynamical Meteorology," Prof. V Bjerknes; "Sur l'intégration des équations aux dérivées partielles par des intégrals définis," Prof. J. Le Roux; "Sur la déformation projective des surfaces," "Sur les relations entre la théorie des groupes et la géométrie," Prof. E. Cartan; "Sur les nouveaux appareils multiplex de télégraphie," J. B. Pomey; "Principe de réciprocité dans les sciences appliquées," Prof. G. Puppini; "Géométrie algébrique," Prof. F. Severi; "Sur le calcul des variations," Prof. L. Tonelli; and "On Ballistics." General Charbonnier.

A CONFERENCE, under the auspices of the British Non-Ferrous Metals Research Association, will be held at High Leigh, Hoddesdon, Herts, during the week-end September 5-8, to which are invited all who need to utilise information systematically, or are interested in the conduct or operation of information bureaux, intelligence services, and special libraries. The programme will include papers and discussions on the functions, future developments, and the methods and equipment of intelligence bureaux, and on their relations with other institutions, including national and public libraries. It is hoped to obtain representatives of such varied fields of activity as government and municipal departments, technical and research institutions, industrial concerns, financial houses, insurance offices, newspapers, and civic and social organisations, all of which have a common interest in the collection, treatment, and dissemination of facts and information relevant to their particular activities Further information may be obtained from Mr. A. F. Ridley, Athenæum Chambers, 71 Temple Row, Birmingham.

THE fifth Entomological Meeting was held at Pusa on Feb. 5-10, 1923, under the chairmanship of Mr. T. Bainbrigge Fletcher, Imperial Entomologist. The Report of its proceedings has recently come to hand, and, although it is less bulky than some of its predecessors, some sixty-one papers are included. These represent almost every branch of applied entomology and afford ample testimony of the importance the subject has attained in India. The institution of meetings of this description brings together workers

who are often isolated at great distances apart with little or no opportunities of direct intercourse The means thus afforded for the ready interchange of information and ideas also attains a more lasting value by the publication of these very fully illustrated Reports. Among the various papers included in the present volume, one of the most important is that by Mr. T. Bainbrigge Fletcher on the possible introduction of the American cotton boll-weevil into India. It appears that the risk of this pest securing a footing in that country is very real, and, after considerable discussion, the Conference passed a resolution that the Indian Central Cotton Committee should consider the advisability of recommending the total prohibition of cotton from America. As an alternative, it is suggested that all bales containing such cotton should be confined to Bombay. The subject of the teaching of entomology in the Indian universities also came up for discussion. The meeting recommended and passed a resolution to the effect that entomology be taught as of equal rank with other branches of biological science in the courses of study for the examinations for degrees in science, including agriculture.

A FISHERY expert is required by the New Zealand Government for co-operation with the chief inspector of fisheries. Particulars of the appointment and form of application may be had from the High Commissioner for New Zealand, 415 Strand, W.C.2. The completed form must be returned by, at latest, August 23.

SOME appointments are about to be made in connexion with the Fuel Research Station, East Greenwich. Candidates must be honours graduates in chemistry (or have equivalent qualifications) with experience in the technology of fuels; or be honours graduates in engineering (or have equivalent qualifications) with similar experience. Research experience is essential for a higher post in chemistry, and industrial experience for a higher post in engineering. Applications must be made on a form obtainable from the Department of Scientific and Industrial Research, 16 Old Queen Street, S.W.1, returnable not later than August 20.

THE American Oil Chemists' Society has established a new quarterly journal which will be the official journal of the oil and fat industry in the United States. The new publication will deal with the chemical considerations of oils, fats, and related materials such as oil meal feeds and fertilisers, paints, soaps, foods, and packing-house products. H. S. Bailey, chief chemist of the Southern Cotton Oil Company, heads the board of editors, composed of the leading American chemists in this field. The first number is to appear this month from the press of the publishers of the American Chemical Society publications. Correspondence regarding subscriptions should be sent to Fred H. Smith, Managing Editor, Experiment, Georgia, U.S.A.

THE Wisconsin Survey Bulletins Nos. LII. and LIV. include a general soil survey of the south part of North Central Wisconsin, and a detailed survey by counties of the southern and older portions. Each section is preceded by a general description of the area concerned, with a summary of the various series of soils found in the district. These groups are then treated in detail, special attention being directed to the economic aspects, such as topography and drainage, native vegetation, and the present state of agricultural development. Each survey is illustrated by an excellent soil map to which a legend is appended in which the soils are grouped according to their surface features and drainage, and are further classified in accordance with their uses and adaptation, fertility, and methods of improvement.

A NEW and much more convenient *format* has been adopted by the Ministry of Agriculture and Fisheries for its fishery publications: it is understood that this is a very great reform, accomplished with difficulty. Three papers are noticed here: Vol. 6, No. 1, a study by Dr. E. S. Russell of the seasonal variations in the chemical composition of the oyster. The paper is based on a large series of analyses made by the staff of the Government Chemist. Vol. 6, No. 5, by J. N. Carruthers, deals with the "intensive" plaice investigations of 1921, particularly the marking and transplantation experiments. Vol. 7, No. 1, is an account of the development of the cod by Prof. A. Meek. The author has been able successfully to make sections of developing cod eggs—a result of considerable value—and has evidently made a contribution of importance to the study of teleostean embryology This embryological detail has, however, been omitted from the paper "as unsuitable in a fisheries publication," and the figures and results actually included are mainly such as have long been familiar in fisheries reports—pictures of fish embryos as seen through the outer membranes and useful only for the purpose of identification of the eggs.

THE Leicester Museum, Art Gallery, and Library Bulletin, of which the first number was issued in June, is in itself a token of progress. It announces another advance in the experimental appointment of Miss F. A. Rogers as guide demonstrator to all three institutions; the extension of this service to the libraries of the town is, we believe, a novelty. The main object of the Bulletin is to direct attention to recent accessions. Those mentioned in the present number comprise an ancient Egyptian funeral boat of the XII. Dynasty, a single-handed turret clock of about A.D. 1700 from Aylestone Church, a bronze, "The Mourning Woman," by Epstein, and a number of books on hosiery manufacture and the related textile industries The Bulletin is intended, for the present, to be distributed gratis at quarterly intervals.

A BEAUTIFUL album of views in the Canton of Graubünden or Grisons has reached us from the Grisons Tourist Information Office, Coire (Chur), Switzerland. The album includes striking illustrations of Klosters and the Canardhorn, Arosa, Flims-Waldhaus with its lakes and pine-woods, St. Moritz, Silvaplana, Maloja, the Morteratsch glacier, the fine Bernina Pass to Alp Grun with the valley and the lake of Poschiavo below, the National Park, Pontresina, and many other places in the Upper and

Lower Engadine. Few areas in Switzerland can offer such a variety of interest and charm as the Engadine. There are mountain peaks, glaciers, well-shaded walks, and lakes, while the remarkable railway, going to a height of 7400 feet, from St. Moritz to Tirano, with conveniently placed stations, make most of the beauty spots in the district easily accessible to visitors who are not mountaineers or cannot undertake long excursions in the high Alps. In the Engadine the mountains are wooded to a greater height than anywhere else in the Alps, and as the general level is about six thousand feet, the district has advantages over most of the places visited by tourists. Pontresina is one of the best centres, and a holiday spent there cannot fail to be of benefit to both body and mind.

MESSRS. DULAU AND CO., LTD., have just circulated a catalogue (No. 114) of books and papers on conchology, mollusca, and minor classes—recent and fossil. Upwards of 1300 titles are given in the list, which will doubtless interest many readers.

READERS of NATURE on the look-out for bargains in books should obtain Catalogue No. 237 from Messrs. W. Heffer and Sons, Ltd., Cambridge, in which are given the titles of many books of science now offered for sale in new condition at greatly reduced prices—the books being "remainders."

WE have received from the British Dyestuffs Corporation, Ltd., a price list of fine organic chemicals for research work, indicators, microscopic stains, and medicinal and photographic chemicals. A very extensive range of products at reasonable prices is available, and it is evident that great progress has been made in the fine chemical industry.

MESSRS. H. K. LEWIS AND CO., LTD., 136 Gower Street, W.C.1, have just issued, at 1s. net, a supplement (1921–1923) to the catalogue of their Medical and Scientific Circulating Library. It should be very useful, not only to users of the library, but also to students in general of scientific literature, being practically a list of the science books published during the period named, consisting of a classified index to subjects in addition to the catalogue itself, which is arranged alphabetically under the names of the authors. It gives the date of publication of the volumes included.

MESSRS. W. H. HARLING, of 117 Moorgate, London, have just issued a new illustrated catalogue of drawing instruments, mostly of their own design and manufacture. These include, besides the usual group of engineers' drawing materials such as scales, parallel rules, T-squares, set squares, drawing boards, etc., a few more elaborate instruments, such as pantographs and eidographs, which should appeal to the increasing number of people who frequently resort to graphical methods. There is a cheap new pantograph which enables drawings and plans to be reduced by sixteen different ratios and enlarged to four times. A more expensive but much more accurate instrument is the eidograph, designed to provide the accuracy required for fine details of map construction. The instrument will enlarge with this accuracy up to a ratio of 1 in 4.

ERRATUM.—Dr. H. O. Forbes writes: "By a very regrettable oversight in correcting the proofs of my communication in NATURE for August 2, 'Pre-Columbian Representations of the Elephant in America,' Dr. Maudslay's name was misspelt Maudsley."

Our Astronomical Column.

ENCKE'S COMET.—This comet was detected on its return by Prof. G. van Biesbroeck at the Yerkes Observatory on July 31. Its position at $20^h\ 45{\cdot}6^m$ G.M.T. on July 31 was R.A. $3^h\ 24^m\ 53{\cdot}4^s$, N. Decl. $28°\ 6'\ 27''$, Magnitude 16·0. The position is within 1′ of Matkiewicz's prediction, according to which perihelion will be reached on Oct. 31·42 G.M.T. The comet should become visible to ordinary telescopes in the last week of August.

THE TOTAL LUNAR ECLIPSE OF AUGUST 14.—We are passing through a period of eighteen years (1920–1938), during which no total lunar eclipses are visible in England under really good conditions. That on August 14 will, however, give some opportunities for observation, especially towards the close of totality. Sunset is at 8 25 P.M. (summer time), the middle of eclipse at 9·20, the end of totality 10 9, last contact with umbra 11.9. The eclipse is nearly central, its magnitude being 1 66 in terms of the moon's diameter. The degree of illumination, and colour, of different portions of the eclipsed moon should be studied, since they give interesting information as to the transparency of the terrestrial atmosphere. Total eclipses can also be used for obtaining improved values of the moon's diameter, by observing the occultations (both disappearance and reappearance) of faint stars. This requires co-operation between a large number of observers; the moon will be too low for observations of this kind in Europe, but some lists have been prepared for southern observers.

A NEW FORM OF ORRERY.—The *Times* of July 31 describes a very interesting method of demonstrating celestial phenomena which is being installed in the Deutsches Museum at Munich. It was constructed by the well-known optical firm, Messrs. Zeiss, of Jena, and consists of about forty optical projectors which throw images of the various heavenly bodies on the white inner surface of a spacious dome. Their relative movements and changes of aspect can be exhibited in an instructive manner.

The ordinary cinematograph can be usefully employed as an aid to astronomical education. It will be remembered that Mr. Maskelyne took a successful film of the total solar eclipse of May 1900 (exhibited at a meeting of the Royal Astronomical Society), and the attempt was repeated in Australia in 1922; but no one seems yet to have realised the possibilities of the method in explaining elliptical or parabolic motion, or various other points in which a moving picture would give far more convincing demonstration than the ordinary diagrams of the text-books.

THE PREPARATION OF THE "GESCHICHTE DES FIXSTERNHIMMELS."—Prof. R. Schorr writes to say that the preparation of this work is being continued at Berlin, Prof. Paetsch having been appointed by the Prussian Academy of Sciences to superintend it. Prof. Schorr is making an independent study of the proper motions of the stars contained in the published volumes (R.A. 0^h to 2^h). The note in this column on July 12 gave the erroneous impression that he was taking a part in the Geschichte itself.

Research Items.

The Antiquity of Man in California.—In *Science* for July 4, Dr. John C. Merriam, in surveying the results of the investigations into the question of the antiquity of man in California carried out by the University of California during the last twenty-five years, points out that the Californian coast region has been in almost constant movement throughout the later geological periods and thus affords a continuous record of the processes of erosion and deposition and of the life of the region during these times. Four lines of investigation have been followed.—(1) the shell-mounds have been examined from the deposits of known culture to those of the earliest times; (2) cave deposits have been explored; (3) pleistocene and recent land, stream, lake and marine deposits in which human remains are likely to be found have been studied; and (4) the evidence relating to the occurrence of human remains or implements in gold-bearing gravels or other ancient deposits has been reviewed. Up to the present, all human remains discovered belong to the type which has been recognised as "modern" and none belong to a geological formation older than the recent period. In the same issue of *Science*, Dr. Chester Stock follows with an account of the geological conditions in which the skeletal remains of six individuals were found in the course of the construction of a sewer at Los Angeles in March last at depths of 18 ft. and 23 ft. The skulls, so far as they have been compared, are of modern type. Some of the remains are considerably mineralised. They present the appearance of having been mired in under bog or marsh conditions rather than washed in. No pleistocene or recent mammals were associated with the human remains, but a comparison with similar deposits in the immediate vicinity suggests the probability of a date later than pleistocene, though of considerable antiquity.

New Species of Shipworms in Bermuda.—As part of the inquiry taking place in the United States on the activities of shipworms, Dr. E. L. Mark, Director of the Bermuda Biological Station, installed test-boards at four stations in Bermudan waters. The specimens of shipworms which attacked these blocks have been examined by W. F. Clapp (Proc Amer. Acad., Arts and Sci., vol. 59, 1924). He reports that the attacks were not so severe as those caused by shipworms at Key West, Florida, and in the West Indies, but the ravages by Limnoria were so extensive that the posterior ends of many of the shipworm tubes were soon exposed to the action of the water, resulting in the premature death of many of the shipworms, so that specimens of large size were rare. The destruction caused by Limnoria was found to be about an inch in twelve months. Of the six species of shipworms received in the test blocks three are new; descriptions of two of these are given, but the author desires further material for the study of the third species before giving an account of it. The genus Bankia (Xylotria) is not represented either in the present collections or in any previous records from Bermuda.

Additions to the Brackish Water Fauna of Spain.—There is still much to be done in the investigation of brackish water faunas throughout the world, and if the curious discoveries of Enrique Rioja, in the Rio de San Nicolás at Gandía on the west of Spain, are to be taken as typical the investigations will yield some startling results in geographical distribution. He found, in the first place, in the streams debouching in the harbour of Gandía, colonies of a small serpulid worm which spread over stones, grew on the submerged keels of old boats and such like. The serpulid he identifies as *Mercierella enigmatica*, a species described by Fauvel, in December 1922, as occurring in the brackish water of the canal at Caen, the only place where it has been found until now. Rioja gives a good description and some excellent figures of the species. (Bol. Real Soc. Espag. Hist. Nat., tome xxiv., 1924, p. 160-169.) But growing amongst the tubes of Mercierella was a more remarkable form, a minute hydroid which the author identifies with *Annulella gemmata*, a new genus and species minutely described by Ritchie from collections made at Port Canning, Bengal. The characters of the two forms agree; in Bengal, as in Spain, the species frequented brackish water; and in Spain Rioja has been able, as Annandale was in India, to keep examples alive in the laboratory in a mixture of sea and fresh water. This occurrence of Annulella, so far distant from its original place of discovery, indicates either a very widespread distribution of brackish water species, or possibly an environmental effect of this particular medium, inducing close convergence of structure, in forms not necessarily directly related.

The Symbiotic Organ in Aphids.—In his studies on the development of Aphids, L. B. Uichanco (*Philippine Journ. Sci.* vol. 24, No. 2, 1924) deals especially with the history of the symbiotic organ or mycetom. The follicular epithelium of the ovary apparently becomes infected with the symbionts, which remain in a dormant condition until stimulated to multiplication by the development of the egg. The symbionts break through the follicular epithelium and invade the embryo and especially the vitellophags—which the author calls mycetoblasts. The relation of these to the inflowing granular mass—suggestive of phagocytosis—lends support to the view that the symbionts are extraneous organisms and not by-products of the insect's own metabolism. The mycetoblasts form a globular mass in which definite cellular differentiation takes place shortly before segmentation of the germ-band, some thirty to seventy mycetocytes being produced. After birth of the aphid, the mycetocytes, which lie in the abdominal cavity, do not further divide, but they increase in size and the symbionts multiply. In the adult aphid, the mycetocytes begin to degenerate one by one until at the end of life very few remain. The mycetom is present in every aphid whether male, female, or parthenogenetic. In its development, the aphid egg differs from that of related groups in that the periplasm and afterwards the blastoderm leave an opening at the posterior pole so that there is direct communication between the follicular epithelium and the egg cavity. The author regards this as a special adaptation by which the symbionts are enabled readily to enter the egg cavity.

Estimation of Wind above Fog.—Mr. L. F. Richardson has devised a method for use in estimating the wind above fog or low cloud which he describes in Meteorological Office Professional Notes, Vol. 3, No. 34. The procedure is relatively simple. In the middle of a large uninhabited field a steel roof is supported on posts. The observer shelters under this roof, through a hole in which is projected a smooth-bore gun. The gun is mounted on a special mounting which enables the observer to vary its tilt. The aim of the observer is to vary the tilt in such a way that the ball which is fired from the gun falls on the roof.

The tilt which attains this object is called the balancing tilt, β, and it is read in two components, the components which Mr. Richardson designates by β being the cosines of the angles between the axis of the gun and the east-west line and the north-south line respectively. The gun is first loaded with a steel ball and sufficient powder to carry the ball up to a moderate height, say 100 m. By trial and error, and the use of a table giving corrections to β necessary to correct certain errors in point of fall of the ball, the tilt necessary to bring the ball back down on the roof of the shelter is evaluated. The charge of powder is then increased so that a greater height is attained, and so on by successive stages. The limit of height attained by Mr. Richardson appears to have been about 750 m. The height attained by the ball is evaluated by noting the time of absence of the ball, *i.e.* the time from firing until the return impact on the roof. The raw material of observation thus consists of certain times of absence with the corresponding values of β in two directions. The computation of winds at different levels is carried out by the use of certain formulæ given by Mr. Richardson in a paper in Phil. Trans. R. Soc. A. Vol. 223, "Theory of the Measurement of Wind by shooting Spheres Upward." The process is quite straightforward and simple. The paper before us does not indicate the degree of accuracy which may be expected from such observations.

THE RADIOACTIVE CONSTANT OF RADON.—In the *Comptes rendus* of the Paris Academy of Sciences, May 26, Mlle. I. Curie and Mlle. C. Chamié describe a new method of determining the above constant. Suppose two bulbs could be obtained, containing exactly equal quantities of the gas, in equilibrium with the rapidly evolved active deposit; one of them is placed in an ionisation chamber and produces a current i, which decreases with the time. The instant t when i passes through a certain value a is observed, and then the two bulbs are placed together in the chamber, and the instant t' observed when the ionisation current again passes through the value a; then $T = t' - t$ is the half life period of radon. In practice, it is not possible to obtain two bulbs with exactly equal quantities of the gas; but it is shown that if the quantities q_1 and q_2 at time 0 are nearly equal ($q_1 < q_2$), and the times t_1 when one bulb produces the ionisation current a, t_2 when the other bulb produces the same current, and t', when the two bulbs together give a, are determined; then $T = t' - \frac{1}{2}(t_1 + t_2)$. Details of the experimental method employed are given, and the results of four determinations agree to 0·1 per cent., giving $T = 3{\cdot}823$ days with an accuracy equal at least to 1 in 2000, and probably higher than this. Mme. Curie found $T = 3{\cdot}85$ in 1910, Sir E. Rutherford confirmed her value in 1913, and Bothe and Lechner determined $T = 3{\cdot}810$ in 1921.

DISTRIBUTION OF ENERGY IN THE SPECTRUM OF A MERCURY ARC.—M. G. Athanasiu describes in the *Comptes rendus*, Paris Acad. Sci., June 16, measurements of the energy of a number of lines in the spectrum of the mercury arc, with different electrical inputs. The observations were made by means of a thermopile and galvanometer. The lines of the first triplet of the sharp series, the three groups of lines forming the first triplet of the diffuse series, and the three groups forming the second triplet of that series were investigated. The group of yellow lines 5769-90 was also measured. Inputs from 100 up to 300 watts were employed. The energy curves of lines belonging to the same series have the same general appearance, and the ratio between the intensities of two lines of the same series remains nearly constant when the watts are varied. The deviations in the case of the first triplet of the sharp series are not larger than the experimental error (3 per cent.). In the case of the diffuse series the deviations are somewhat larger; this might be expected, since each of these groups contains a line belonging to a different series, the combination series $1p - Dm$ (Fowler). For two lines belonging to different series the ratio of the intensities varies with the watts between large limits, and may be inverted, the energy curves cutting one another. The ratio of the intensity of the yellow group to that of the green line, $\lambda 5460$ (the first line of the first triplet of the sharp series), changes in the lamp studied from 0·5 for 100 watts to 1·25 for 300 watts.

THE NUMBER OF α-PARTICLES EMITTED BY RADIUM.—In the *Zeitschrift für Physik*, June 12, V. F. Hess and R. W. Lawson criticise a recent paper by Geiger and Werner, who have obtained for the above number $3{\cdot}4 \times 10^{10}$, agreeing with the value originally found by Rutherford and Geiger, but differing from Rutherford's later value, $3{\cdot}57 \times 10^{10}$, and from that found by the authors in 1918, $3{\cdot}72 \times 10^{10}$. It is suggested that the platinum used in the construction of the container employed for the emanation, which had to be heated in the course of filling, occluded emanation when cooled; this might easily produce an error of 10 per cent. It is doubtful whether Geiger and Werner are correct in thinking that their scintillation screen, in which powdered zinc sulphide was mixed with castor oil or turpentine oil, gave scintillations corresponding to almost 100 per cent. of the total α-particles, as was the case with the zinc sulphide alone (99·6 per cent.). The method adopted for obtaining the true number of scintillations from the counts is criticised, and the authors conclude that their own previous result is more trustworthy. It agrees much better with estimates derived from the amount of heat produced by the disintegration of radium, the difference being perhaps due, as suggested by Geiger and Werner, to energy liberated in consequence of structural alterations in the nucleus. This energy is not likely to be so large as would be indicated by Geiger and Werner's number.

THE PRODUCTION OF SULPHURETTED HYDROGEN BY FERMENTATION IN THE BLACK SEA.—Six cubic centimetres of hydrogen sulphide per litre has been found at a depth of 2970 metres in the Black Sea, and it has been suggested that this is due to the decomposition of organisms which are brought in by currents from the Mediterranean and killed by the alteration in the salinity. Sulphates in the water would also be reduced, with the formation of hydrogen sulphide. Zelinsky and Brousselovsky ascribed the phenomenon to the action of a definite organism, *Bacterium hydrosulphureum ponticum*, on the sulphate; but Nadson considers this bacterium to be an ordinary putrefactive ferment, *Proteus vulgaris*. Mr. B. Issatchenko, who gives the above particulars in an article in the *Comptes rendus* of the Paris Acad. Sci., June 23, has recently taken part in a voyage of exploration in the Black Sea, and has found a small characteristic vibrion, with all the characteristics of *Microspira aestuarii*, and probably identical with this organism. It grows abundantly under anaerobic conditions, without the presence of any albuminoid substance, in a solution containing salts of organic acids and sulphates, producing 0·3 to 0·5 of hydrogen sulphide per litre. Issatchenko considers it probable that the hydrogen sulphide in the lower layers of the Black Sea is largely due to this organism.

The Scottish Cattle Breeding Conference.

THE student of agriculture now passing through the schools is receiving an introduction to the newer sciences that have their applications in agricultural practice, but from the older generation of stock-breeders the recent advances in these fields of inquiry are completely hidden and, before their conservative indifference towards science can be overcome, much work of an educational nature must be undertaken. It was for the purpose of displaying recent achievements in the field of agricultural physiology that the Scottish Cattle Breeding Conference, held at Edinburgh on July 7-12, was convened. It was intended also to show to the breeder part of the State schemes of research in relation to agriculture in operation.

The Conference was undoubtedly an event of outstanding interest in the history of livestock breeding in Great Britain and can be accounted a success, although, as was anticipated, British breeders did not attend in large numbers. It was not to be expected that the man who regards himself as a successful breeder could easily be attracted by a scheme that had for its object the systematic collection of information that would help to make breeding successful. As the days of the Conference passed it became increasingly clear that there exists a great gulf between the scientific worker and the breeder that cannot easily be bridged. Each speaks a tongue that is foreign to the other, and the outstanding need in British agriculture to-day is the scientifically trained agricultural journalist who shall interpret the work of the man of science to the breeder. The programme was so arranged that full opportunity was given to both to learn each other's language and to see each other's point of view and methods. A great deal of time had to be spent in discussing the very A B C of genetical science, and there can be no doubt that had these hours been available for more advanced matters the Conference would have been more profitable.

The speeches of the chairman of the Board of Agriculture for Scotland, the Lord Provost of Edinburgh, the Secretary of State for Scotland, the president of the Shorthorn Society and of Dr. Robert Wallace, emeritus professor of agriculture in the University of Edinburgh, at the opening session, created just the atmosphere in which the free interchange of experience flourishes, and the stage was set for the business of the five following days.

Early in the proceedings Major E. N. Wentworth, a geneticist of repute and the present head of Armour's (Chicago) Livestock Bureau, outlined the relations between the science of genetics and practical breeding. He explained the reasons why the spectacular advances in the pure science have not been quickly followed by parallel advances in the craft, and why genetical knowledge is not likely to affect, at all profoundly, breeding procedure. The reasons are financial in nature. Genetical knowledge can best be employed in the creation and development of new breeds, but this work is made quite prohibitive because of the expense and the length of time required. It is a matter of the greatest difficulty to displace the already established even with a more satisfactory breed, and almost impossible to overcome tradition.

Major Wentworth mentioned one matter of considerable interest. The American consumer is exhibiting an ever-increasing demand for baby-beef (yearling cattle), whilst the producer, disregarding this demand and certainly fighting a losing battle, is still intent on breeding for increased size. The problem of meeting the demands of the consumer is to be tackled by the geneticist and breeder working in collaboration.

Dr. Chr. Wriedt, of Kristiania, in a paper on the inheritance of abnormal conditions, opened up a subject of profound importance to the livestock industry. During the discussion that followed it was pointed out that any characterisation, detrimental to the individual, which behaves in a mendelian fashion in inheritance is a character in the mendelian sense, and can be eradicated from a stock only by the adoption of mendelian methods of breeding. Already a considerable number of such characters that render the possessor non-viable or more or less imperfect have been recognised. Monstrous calves, deformed lambs, still-births, certain forms of sterility, of blindness, and of deafness, white heifer disease, hermaphroditism, undescended testis, skin defects, and many other conditions, have been shown to be mendelian characterisations, and it can be expected that the list will be considerably augmented when the veterinarian and the breeder recognise that the present-day knowledge of the hereditary mechanism has been gained through the study of the inheritance of similar conditions in the usual laboratory animals. It is probable that a great proportion of the anatomical defects and physiological derangements that are found in cattle will be shown to be mendelian characters

Prof. L. J. Cole, chief of the Animal Husbandry Division of the U.S. Bureau of Animal Industry, in one of his many papers dealt exhaustively with the vexed question of the effects of inbreeding, maintaining that the harmful effects depend entirely upon the hereditary constitution of the individuals concerned and not upon any pernicious attribute of inbreeding in itself. There is a great deal of evidence which supports this contention, but the unfortunate fact remains that it is not possible for the geneticist to be really helpful in this matter. It is unwise to advise the breeder to undertake inbreeding in order to achieve rapid improvement in his stock, when the records of so many domestic breeds show that the individuals are carrying factors for harmful recessive characters which would quickly be disclosed were inbreeding practised. It is true that by this method of breeding a stock could be purged of its undesirable characters, but it is equally true that during the process the stock might become extinct In certain cases stockbreeding has become one sustained effort to retain heterozygosity in order that undesirable characters may not be expressed, and the homozygosis that follows inbreeding is the last thing that the breeder desires.

Two papers of great interest which roused great enthusiasm among the breeders were those on the reproductive functions and on the development of the udder in the cow, given by Mr. J. Hammond, of the Cambridge Institute of Research in Animal Nutrition, and these led the way to a discussion on milk-recording which was opened by a paper by Mr. B. A. Sanders, of Cambridge. The breeder was shown clearly how difficult the genetical interpretation of milk records is made by the efforts of the husbandman. Until all variations of extraneous origin are accounted for the genetical basis of milk-yield cannot be begun, and even then it is to be expected that this will prove to be a very complicated multi-factor affair.

There is no doubt that shortly some modified system of advanced registry will be adopted in Great Britain in the recording of milk cattle. Mr. Mackintosh, of the National Institute for Dairying, Reading, helped

on this movement considerably by his plea for a uniform system of stating milk and butter-fat records. He pointed out that the present lack of uniformity renders comparative studies impossible, seriously embarrasses the breeding of dairy stock, and denies the overseas buyer those data to which he is entitled. He urged that the lactation period of a cow should be recorded in days; that the date of the next calving and details as to whether a full-time calf had been born should be stated; that the records of the milk-yield should be based on weighings at not more than weekly intervals and should be stated only in pounds; that the records of butter-fat should be based on a sufficient number of samples taken at fairly spaced intervals during the lactation period, and that the total weight of the butter-fat produced should be stated in pounds. The conference unanimously supported Mr. Mackintosh.

The fifth day of the meeting was given over to papers by the breeders, who were asked to define their problems. Most of the difficulties presented were such as are at the present time quite beyond genetical analysis, for they concerned highly improved expensive stock, and in many instances passed far into the realms of veterinary medicine. Nevertheless certain of the breeders' problems are problems no longer, and it was very satisfying to the geneticist to be able to explain away the lesser difficulties which still harass the breeder.

During the whole of the week the discussions were eager and the audience insatiable for information. It was shown quite conclusively that this was to be but the first of many such meetings. Before the next, however, it is to be hoped that the Journal of the Ministry and of the Board of Agriculture for Scotland, and also the series of monographs now being issued by the Ministry, will find their way into the hands of many more of the breeders of Great Britain, and that the geneticist will be co-opted on the councils of the various breed societies. F. A. E. CREW.

The Imperial Mycological Conference.

ON July 2, mycologists from all parts of the British Empire met in conference at the Imperial College of Science, South Kensington. It was the first gathering of its kind, and marks a distinct advance in organising the campaign against fungous diseases of agricultural and plantation crops. The conference was called by the Colonial Office to discuss the future arrangements for the Imperial Bureau of Mycology, but a large part of its time was taken up with interesting and useful discussions on various aspects of plant disease work throughout the Empire. Official delegates represented most of the Dominions, Colonies, and Protectorates, while the members of the Committee of the Bureau attended the meetings, as well as a number of mycologists from the British Isles who were invited to be present. On the afternoon of July 2 the delegates were entertained to tea at the Bureau, and on the evening of July 4 the British Mycological Society acted as hosts at a dinner given to the overseas mycologists in the Criterion Restaurant. The conference had been arranged to precede the Imperial Botanical Conference, which was held the following week, and the delegates had the opportunity of taking part in the meetings and excursions arranged by the latter conference.

Earl Buxton, chairman of the Committee of Management of the Bureau, received the delegates, and in his opening address spoke at length of the founding of the Bureau, the scope of its work, and the economic importance of plant diseases. The rest of this day, as well as the last part of the closing meeting, was spent on business matters.

On Thursday, July 3, under the presidency of Mr. W. Nowell, Assistant Director of Agriculture, Trinidad, Mr. Tattersfield (Rothamsted) opened a discussion on "The Co-ordination of Investigations of Fungicides," expressing the view that the explanations of fungicidal action are, in general, inadequate, and that research should attempt to correlate chemical constitution with toxic action. The subject gave rise to an animated discussion in which Dr. Brierley (Rothamsted), Mr. Dowson (Wisley), Dr. Wormald (East Malling), Mr. Briton-Jones (Long Ashton), Mr. Massey (Sudan), Mr. Nowell, Mr. Summers (Shirley Institute), and Dr. Butler (Bureau) took part, and finally the suggestion, made by Dr. Brierley, that a committee be appointed for the co-ordination of work on fungicides was referred to the Managing Committee of the Bureau for consideration. The second half of this session was occupied with the consideration of "Plant Disease Surveys in the British Empire." Dr. Butler, who introduced the subject, spoke of the many ways in which plant disease surveys are invaluable aids to the phytopathologist. Mr. A. D. Cotton (Kew) described the origin and development of the survey of England and Wales and emphasised the importance of a survey for the agricultural progress of any country. Dr. Shaw (India), Mr. Gadd (Ceylon), and Dr. Doidge (South Africa) reviewed the survey work being done in their respective countries.

In the afternoon, Dr. Pethybridge (Ministry of Agriculture) in the chair, Mr. Cunningham (New Zealand) spoke on "The Standardisation of Popular and Scientific Nomenclature in Plant Pathology." He illustrated the necessity of standardisation by a few well-chosen examples, and showed how the multiplication of common names, especially for those diseases of which the causal organisms are not known, must lead to confusion. The considerable divergence of the scientific names adopted by different workers, as well as their frequent change, is also liable to cause trouble. Mr. Cotton stated that the Phytopathological Committee of the British Mycological Society had undertaken the work of the standardisation of common names in England and enunciated the principles the committee had decided to adopt. Dr. Murphy (Irish Free State) suggested that some understanding with the United States should be reached on the subject. Various speakers mentioned the importance of the popular name in dealing with the farmer.

The next paper was one by Mr. Tunstall, of the Indian Tea Association, on "The Encouragement of Private Enterprise in the Investigation of Plant Diseases." After describing the development of the scientific department of the Association, which had more than satisfied the tea planters with the results obtained, the speaker expressed the view that continuity of the work was essential and the use of highly paid specialists for short periods unsatisfactory. The Government could encourage non-official enterprise by means of grants, and in return should have a call on the services of the enterprise. Dr. Butler spoke of the excellent work being done by private enterprise in various parts of the world, and considered that such enterprise need not clash with Government institutions. Mr. Gadd outlined the rubber research scheme established in Ceylon in conjunction with the Rubber Growers' Association. Col French (Empire Cotton Growing Corporation) gave an account of the work of the Corporation, and Dr. Pethybridge mentioned the enterprise of the glass house industry near London in this respect.

The morning session on Friday, July 4, when Prof J. B. Farmer (Imperial College) and later Mr. Stockdale (Ceylon) presided, was occupied wholly with diseases of tropical plantation crops. Dr. Doidge gave an account of the campaign to eradicate from South Africa the canker of citrus trees (*Pseudomonas citri*), which was probably introduced on some Japanese stocks. The cost of the campaign to date was 117,000*l*., and though it was too early to be sure that the disease was completely stamped out, the results were promising. Various other citrus diseases were briefly reviewed. In the discussion which followed, Mr. Nowell expressed the opinion that the present campaign in South Africa, if successful, would no doubt have a considerable reaction throughout the world. Mr. Massey followed with a paper on "The Cotton Diseases occurring in the Sudan," dealing particularly with the outbreak of *Bacterium malvacearum* in that area. The disease is seed-borne, and the problem of control essentially one of seed disinfection, which is being carried out on a large scale with this year's seed. The discussion was largely concerned with this disease, but Mr. Briton-Jones (formerly mycologist in Egypt) spoke of the diseases occurring in Egypt, and Mr. Summers of the mildewing of cotton fabrics. Prof. S. F. Ashby (Trinidad) was responsible for leading the discussion on "The Panama Disease of Bananas." After an account of the disease and of the very heavy losses caused by it, especially in Central America, the speaker showed that the real solution of the problem of fighting it was the discovery of an immune variety; the work with this end in view, now in progress at the Imperial College of Tropical Agriculture, was described. Mr. Hansford described the position of affairs in Jamaica with regard to this disease. In the afternoon Mr. Bunting spoke on "The Diseases of Cacao in the Gold Coast," mentioning particularly the newly discovered cocoa parasites of that Colony.

A subject of fundamental importance was raised by Mr. Nowell, on Friday afternoon, in his paper on "The Influence of Soil Conditions on Plant Diseases." The speaker put forward the view that many diseases of plants are primarily due to soil conditions and that the fungi are only parasitic when these conditions render the hosts susceptible. Diseases of this nature could be classified as root diseases and debility diseases. Numerous examples were given, particularly root rot of sugar-cane, which has been ascribed to various fungi and which can be completely overcome by good manuring. In the vigorous discussion which followed, Mr. Tunstall strengthened the views advanced by citing additional examples from his experience of tea diseases, and Dr. Shaw spoke of the differences in the incidence of the wilt of pigeon pea on the permanent manurial plots at Pusa in India.

At the closing session of the conference on Saturday, July 5, Mr. Nowell presided, whilst Dr. Shaw and Dr. Murphy addressed the meeting on "The Application of the Results of Mycological Investigations," the former from the point of view of the tropical countries with a native population, and the latter from that of temperate countries with white farmers. Dr. Shaw described the organisation of the agricultural service in India to deal with plant diseases and the methods adopted for conveying information to the cultivator. A full discussion followed, in which Mr. Bunting, Miss Welsford (Zanzibar), Dr. Butler, Dr. Doidge, and Mr. Stockdale took part. The last part of the closing session was occupied with business matters, Sir David Prain being in the chair, and a number of resolutions were passed dealing chiefly with the establishment and finances of the Bureau, and recommending that similar conferences should be held every five years.

University and Educational Intelligence.

Cambridge.—The Research Studentship offered annually by Trinity College to a graduate of another university who intends to come to Cambridge with a view to the degree of Ph.D. has been awarded to Mr. Joseph Ratner, of Columbia University, and a teacher in the Department of Philosophy at the College of the City of New York, for research in ethics. The Dunning Scholarship, open on this occasion to prospective candidates for the degree of Ph.D., has been awarded to Mr. Lawrence St. Clair Broughall, of University College, London, for research in physics. A Dominion and Colonial Exhibition has been awarded to Mr. J. B. Williams, of McGill University, Montreal.

Leeds.—Mr. J. R. R. Tolkien has been appointed professor of English Language. He has been Reader in English Language in the University since 1920, and has held several teaching and examining posts at Oxford and elsewhere. The institution, in the English Department of the University, of a separate Chair of English Language, is in accordance with the constitution of corresponding schools at Oxford, Cambridge, Liverpool, Manchester, and elsewhere; and indeed it restores the position which at one time obtained also at Leeds.

Dr. C. E. Gough has been appointed to the Chair of German at the University, which has been in abeyance siuce 1916.

Dr. S. Brodetsky has been elected the first occupant of the Chair of Applied Mathematics. He graduated as Senior Wrangler at Trinity College, Cambridge, in 1908, held the Isaac Newton Studentship for research in Mathematical Astronomy, and thereafter proceeded to the degree of Doctor of Philosophy at Leipzig. On returning to this country, he joined the mathematical staff of Bristol University in 1914, and came to Leeds in 1919 as Reader in Applied Mathematics. Prof. Brodetsky has produced a long series of papers on many branches of Applied Mathematics, and has devoted special attention to aerodynamics.

London.—Dr. A. W. M. Ellis has been appointed as from October 1, 1924, to the University Chair of Medicine tenable at the London Hospital Medical College.

Dr. E. V. Appleton has been appointed as from August 1, 1924, to the Wheatstone Chair of Physics tenable at King's College. Since 1919 he has been supervisor in physics and mineralogy at St. John's College, Cambridge, of which he is a fellow, and demonstrator and lecturer in the Cavendish Laboratory.

The following doctorates have been awarded, the thesis in each case following the name of the candidate:—*Ph.D.* (*Science*): Mr. J. F. Congdon (King's College), "The Kinetic Energy of the Electrons emitted from a Hot Tungsten Filament in an Atmosphere of (*a*) Argon, (*b*) Hydrogen"; Mr. J. W. C. Crawford (Battersea Polytechnic), "Experiments on the Synthesis of Carnitine"; Mr. A. T. Fuller (Battersea Polytechnic), "Terpineol: its Resolution and Optical Properties, with a Description of some of its Derivatives"; Mr. V. G. Jolly (University College), "Platinocyanides"; Mr. M. A. Matthews (Sir John Cass Technical Institute), "Some Anthracene Derivatives"; Clara Agnes Pratt (Imperial College—Royal College of Science), "Growth Conditions of Fungi"; Mr. H. E. M. Priston (Battersea Polytechnic), "The Alcohols of the Hydroaromatic and Terpene Series: (*a*) Fenchone and the Fenchyl Alcohols, (*b*) The Esters of Borneol and Isoborneol"; Mr. E. J. Weeks (Sir John Cass Technical Institute), "Hydrogen Overpotentials in Alkaline and Neutral

Solutions"; Mr. W. Clark, "On the Light Sensitivity of Photographic Emulsions"; Adela Gwendolyn Erith (University College, Reading), "A Monograph on White Clover (*Trifolium repens*, L.)"; Mr. P. Lewis-Dale, "An Investigation into the Nature of the Compounds occurring in the Liquid obtained when Oil Gas is submitted to Pressure, with Suggestions as to the possible Utilisation of the Liquid"; Mr. J. N. Sugden (Imperial College—Royal College of Science), "Hydration of Electrolytes and Non-Electrolytes in Aqueous Solution."

MANCHESTER.—The Council has accepted an offer from the brothers and sisters of the late Mr. Philip Buckle, a former student of the University, for the endowment, in his memory, of a scholarship in some branch of Agriculture or Zoology.

The following appointments have been made: Associate professor of applied mathematics (for one year), Dr. T. M. Cherry; Assistant lecturer in engineering, Mr. J. B. M Hay; Demonstrator in human physiology, Miss Hilda Linford; Demonstrator in experimental physiology, Mr. E. Nevill Willmer.

SHEFFIELD.—Lord Bearsted has made a gift of 10,000*l*. to the department of metallurgy for the encouragement of study and research.

APPLICATIONS are invited for the professorship of pathology in the University of Melbourne. They should reach the Agent-General for Victoria, Melbourne Place, Strand, W.C.2, by September 20 at latest. Particulars of the post may be obtained from the Agent-General.

IN the report for 1923 of the University of Adelaide, it is announced that the original University Act, which provides that a subsidy of 5 per cent. up to 10,000*l*. p.a. shall be paid by the Government on all endowments by private benefactors, has been amended by raising that limit to 20,000*l*. p.a., thus encouraging further donations. The Council has agreed to assist the Medical Sciences Club in meeting the expense of publishing a journal of experimental biology and medical science, which is to serve as a medium for making known the results of researches carried on in this and other universities. Work conducted in connexion with the University's Animal Products Research Foundation included a comparison of the growth of animals initially below the average weight with that of animals initially above the average. The jubilee of the University is to be celebrated in 1926.

COMPLETE reform of the preparatory school curriculum seems yet a long way off. The Board of Education exercises no control over any of these schools, and, with one or two exceptions, is not invited to express an opinion on their efficiency. Preparatory school headmasters form a close corporation influenced mainly by the requirements of the Common Entrance Examination, upon the results of which scholarships to the public schools are awarded. In most preparatory schools science is regarded as an expensive luxury which brings no adequate return in the way of "successes." There are, however, a few progressive headmasters who, greatly daring, put the cause of education first. It is interesting to note that Mr. Seymour Bryant, St. Piran's, Maidenhead, has recently added a new block containing an engineering shop and drawing office, two new well-equipped dark rooms, wireless room, technical library, and music rooms. The list savours of pleasure as well as business, but this is a characteristic of a school in which the tradition of Sanderson of Oundle is followed.

Early Science at the Royal Society.

August 10, 1664. The secretary presented the society from Mr. Beal with a box full of several stones, by which the latter conceived it might be seen what is the process of the plastic spirit in shaping perfect cockles, muscles, scollops, headless serpents, fishes, thunder-stones, etc. Then was begun to be read Mr. Beal's annexed discourse relating to these stones, the rest being referred to another meeting, because Mr. Birchinsha was without, expecting to be called in, for the prosecution of the experiments with the monochord.—

Ordered—That Dr Wilkins be desired to speak to the lord Berkley, that he would please, in the name of the Royal Society, to move the committee of the company for the East Indies, that, by their interest in these parts, they would procure such answers, as may satisfy the inquiries to be sent to them; as also such particulars of the productions and curiosities of nature, as shall be specified unto them, and such others, as those parts do afford, and they by their industry can inquire for the use of the said society. Moreover, to write . . . to take special care of the transport of such things.

August 13, 1662. It was voted, That the president attended by the council, and as many of the society as can be obtained, should wait upon the King, after his coming from Hampton-Court to London, to give him humble thanks for his grace & favour: and that in the meantime the president should acquaint his majesty with their intention: and that afterwards the lord chancellor be thanked likewise, as also Sir Robert Moray, for his concern and care in promoting the constitution of the society into a corporation.

August 14, 1686. A letter was read describing the manner of transporting the great globes made for the cardinal d'Estrees by father Coronelli, designed to be presented to the French King; which manner was, that the large carts, in which they were to be carried, were placed upon low wheels, with four axle-trees, that so the wheels might be changed, at the turning of a corner, without altering the position of the case.

August 15, 1666. A letter from Dr Wallis to Mr. Oldenburg, dated at Oxford, was read, importing that whereas he had used to observe in his baroscope, that the sun-shining made the quicksilver to rise, in which the observations of others had concurred; he had this summer in the hot time of June, July and August observed the mercury constantly to rise in the night and to fall in the day. The President affirmed, that he had generally observed the contrary in his baroscope.—

The contrivance for the experiment appointed to shew, that the circular pendulum was made of two strait lines crossing one another, being fitted, as was suggested at the preceding meeting, it appeared, that the motion from the one end of the greater diameter of the circular pendulum to the same end again was equal to two vibrations of the strait line pendulum, equal in length to the former, and moving in the same plane.

August 16, 1686. A note from Mons. Justel was read, giving an account, that a french ship having lately been at the Cape of Good Hope, had been informed by the Dutch there of an expedition, which they had made towards the tropic of Capricorn; and that they had there found a nation, which answered their violins with thirty instruments, and among the rest with one, that was a sort of flute, which was made with a slit instead of holes, and a ferrel case that runs up and down upon it, according to the tone intended by it.

Societies and Academies.

LONDON.

Royal Meteorological Society, July 18 (meeting at the Rothamsted Experimental Station, Harpenden).—Mr. C. J. P. Cave, president, in the chair.—R. A. Fisher: Adaptation of variety to climate. One of the main problems attacked by the statistical laboratory at Rothamsted in recent years has been to ascertain numerically the effect of weather on the yield of farm crops. The Rothamsted data give the yield of wheat on thirteen plots which have been under uniform manurial treatment since 1851, and rain records from a large gauge set up in 1853. From these series of values it has been possible to evaluate the actual gain or loss of each consequent upon an additional inch of rain at any time during the harvest year. The work has involved a detailed analysis of the distribution of rainfall through the year for each year since 1853, some of the results of which are of interest. The total rainfall fluctuates greatly from year to year, but there is some evidence that the fluctuations are not at haphazard, but that at two periods centred about 1879 and 1914 there has been a prolonged spell of significantly increased rainfall. On the other hand, one feature of the rainfall distribution has shown a steady and apparently uniform change throughout the 70 years This involves increasingly wet Decembers, and perhaps drier weather in spring and autumn. Data on this point from other stations would be of great interest.—W. B. Haines: A comparison of three different types of radiation recorder. This paper deals with a comparison of the readings taken at Rothamsted with three types of radiation recorder. The first of these is a recorder of the Callendar pattern, depending upon the difference in temperature between a black and a bright resistance exposed to the sky. These readings are taken as standard. The second instrument (Wilson integrator) reads the amount of alcohol or other volatile liquid which distils from a bulb exposed to the radiation into a similar shielded bulb. The third set of data is the record of hours of bright sunshine from the widely-used Campbell-Stokes apparatus. Reference is also made to a fourth set of data, that given by an evaporimeter of the porous candle type, since the readings of this instrument are correlated to the amount of radiation. A diagram made by plotting the data to suitably adjusted units brings out the following points:—(1) The alcohol integrator gives readings much too low during the winter months. The readings could be correlated for the effect of temperature upon the vapour pressure of alcohol, but there is a large random error which makes it impracticable to advance a correction formula to deduce the true radiation. (2) The hours of bright sunshine should be corrected by a factor depending upon the time of day and year (*i.e.* upon the sun's altitude). A formula deduced by Ångström from the Stockholm data, for calculating total radiation from hours of bright sunshine, is examined and found fairly satisfactory for the Rothamsted data. It is concluded that such a formula, based upon the data at one station, could with due caution be adopted for another station.

PARIS.

Academy of Sciences, June 30.—M. Guillaume Bigourdan in the chair.—A. Desgrez, H. Bierry, and L. Lescœur: Relation between the variations of P_H of waters containing hydrogen sulphide and their transformations when exposed to the air. The changes observed are due to two phenomena, oxidation of the sulphur causing a reduction in the P_H, and loss of carbon dioxide producing a rise in P_H.—A. Recoura: The action of acetic acid on hydrated metallic salts. Acetylated salts. Powdered crystallised copper sulphate, $CuSO_4, 5H_2O$, treated with a large excess of acetic anhydride loses rapidly four molecules of the water. The fifth molecule fixes one molecule of the anhydride, and it has been proved that acetic acid is not formed. The compound produced is $CuSO_4 . H_2O . [(C_2H_3O)_2O]$ The sulphates of nickel and magnesium form similar compounds.—Alfred Rosenblatt: Algebraic varieties of three dimensions, the species of which satisfy the inequality $P_g \leqq (p_g - p_a - 3)$.—R. H. Germay: The elimination of the parameters in Cauchy's method of characteristics for the integration of partial differential equations of the first order.—Georges Giraud: Two formulæ applicable to the numerical calculation of integrals.—Jacques Chokhate: The polynomials of Tchebycheff.—Armand Cahen: Classification of the new continued fractions dependent on an operation $R(z)$ to one unit in excess.—E. Gau: Conditions that a surface may be ruled by deformation.— —— Gros: Finite bending of a circular ring compressed diametrically.—Paul Dumanois: Experimental results on increase of compression in aviation motors. In an earlier communication, some results were theoretically deduced concerning the increased explosion pressures and thermal efficiencies of internal combustion motors when an anti-knocking compound, such as lead tetraethyl, was employed. In the present paper experiments are described which confirm the theoretical conclusions. Experiments were also made to determine whether the temperatures developed at the base of the pistons or at the escape valves were so high as to endanger the low melting material now employed —Louis Breguet: The yield of the propulsion of birds by the motions of the wings.—Louis Roy: The fundamental equations of electrodynamics of continuous media in motion.—Maurice Curie: The photo-electric and phosphorogenic effect —L. Riéty: The electromotive force of filtration —Charles Henry: The calculation of heats of formation and the interpretation of some exceptions to the law of maximum work —J. J. van Laar: The vapour pressure of solid carbon. In a recent communication Wertenstein and Jedrzejewski have given an expression for the vapour pressure of carbon, making use of Langmuir's method (evaporation in a vacuum) and the Knudsen-Langmuir formula. This leads to 5050° C. (absolute) as the boiling-point of carbon. By an independent method the author arrives at 5010° C. (abs) for the same constant. The figure 4200° C. (abs) deduced from the measurements of Lummer and of Mlle. Kohn with the positive crater of the arc is certainly too low.—Francis Perrin: The role of viscosity in fluorescence phenomena — —— Bogitch. The oxidation of chromite and the preparation of chromates. Experiments on heating chromite with various mixtures of lime and sodium carbonate, calcium and sodium carbonates, lime and common salt, lime and sodium sulphate. The influence of temperature and duration of heating were also studied.—P. Lebeau: The thermal fractionation of the gaseous products of the pyrogenic decomposition of some definite compounds. The author has shown that by submitting coal to progressively increasing temperatures, the curve showing the relation between gas yield and temperature is definite and constant for a given fuel. The same method has now been applied to definite compounds (starch, sugar, glucose, casein). The results appear to indicate that the method may be of value in studying organic compounds of high molecular weight.—Ch. Courtot and R. Geoffroy: The

sulphonation of fluorene.—MM. **Maurain, Eblé, Labrouste, Mouronval,** and **Escher-Desrivières**: The propagation of seismic waves in the neighbourhood of the origin. Experiments made with seismographs installed at La Courtine, Felletin, and Ussel, recording the four experimental explosions at La Courtine.—F. **Diénert**: Subterranean hydrology. Details of technique relating to the use of fluorescin and other dyes in tracing the path of underground waters—Ladislas **Smolik**: The influence of heat on the total surface offered by the elements of the soil.—L. M. **Bétancès**: What is a hæmohistoblast?—A. **Rochon-Duvigneaud**: Visual lines of the central fovea (independent vision) and the lateral fovea (associated vision) in the kestrel.— —— **de Luna**: The presence of an accessory ovary in *Drosophila melanogaster*.—A. **Lecaillon**: The new races or varieties which can be obtained by the method of crossing in the silkworm.—(Mlle.) Lucienne **Dehorne**: Remarks on the ephippia of *Daphnis longispina*.—W. **Mestrezat** and M. **Janet**: The dispersion of the electrolytic colloids of the protoplasm in relation with the mineral nutrition of the cell.—Maurice **Piettre** and Clément **Roéland**: Trimyristine, the glyceride of milk.—S. **Mutermilch**: Normal and artificial hæmolysins.

July 7.—M. Guillaume Bigourdan in the chair.—H. **Deslandres**: The extension to some line spectra of a property already recognised in several band spectra.—Maurice **de Broglie** and A. **Dauvillier**: Complementary researches on the Compton effect.—L. **Lumière**, A. **Lumière**, and A. **Seyewetz**: Contribution to the study of the latent photographic image. In experiments on the latent photographic image after fixing, a developer consisting of paraphenylene diamine and silver sulphite acting for 48 hours showed a gradual production of particles, which, under a magnification of 2300 diameters, proved to be hexagonal crystals. These crystals were not obtained when the developer was silver sulphite dissolved in sodium sulphite with addition of formaldehyde, but if a plate after exposure, fixing, and washing were treated with an ordinary organic developer, such as diamidophenol, subsequent treatment with the formaldehyde-sulphite of silver both developed the crystals.—B. **Berloty** was elected a correspondent of the Academy for the section of geography and navigation in the place of the late Elie Colin.—Marcel **Légaut**: Systems of points and the theory of skew algebraical curves.—A. **Demoulin**: Surfaces of the Lie quadrics have only two characteristic points.—Paul **Mentré**: The projective deformation of certain congruences of straight lines.—Rolf **Nevanlinna**: The exceptional values of meromorph functions.—Pierre **Jolibois** and Georges **Normand**: The decomposition of lead tetra-ethyl and its application to internal combustion motors. Pure lead tetra-ethyl is decomposed at 400°, producing finely divided lead. In the cylinder of an internal combustion motor, lead tetra-ethyl would be decomposed at all locally heated points covering these with a layer of metallic lead, thus reducing the curvature of any sharp points tending to become centres of auto-explosion.—Pierre **Idrac**: Contributions to the study of the flight of the albatross. An automatic kinematographic apparatus was utilised in this work: it is concluded that, contrary to all hovering birds previously studied, the albatross does not utilise ascending air currents.—Alfred **Lartigue**: The co-ordination of the thermodynamical properties of water.—André **Marcelin**: Extension of the application of the gas law to superficial solutions.—L. **Vegard**: The luminous spectra of solid nitrogen and their application to the aurora borealis and to the diffused light of the sky at night It is shown that the aurora is probably due to the action of the kathode rays acting upon small crystals of solid nitrogen.—G. **Reboul** and **Bodin**: A new method of production of radiations in the region between the ultra-violet rays and the X-rays Pastilles of various metallic salts are placed between two electrodes connected to a battery of small secondary cells, the fall of potential across the pastille being variable from 90 to 2430 volts. The radiation emitted is easily absorbed, capable of ionising gases, and has a wave-length between the ultra-violet and the X-rays.—Louis **de Broglie**: The general definition of the correspondence between wave and motion.— —— **Lemarchand**: Equilibrium in saline double decompositions in aqueous solution.—L **Chassevent**: The thermal phenomena which accompany the setting of plaster of Paris.—A. **Boutaric** and Mlle G. **Perreau**: A protection effect of suspensions realised by the addition of electrolytes in quantities too small to effect flocculation.—P. **Job**: The electrometric study of the hydrolysis of salts.—André **Job** and Guy **Emschwiller**: The photolysis of the organic iodides. The photochemical limit and the linkage energies. Pure ethyl iodide, in a closed system free from oxygen, on exposure to light gives free iodine and a mixture of ethylene (53 per cent.), ethane (36 per cent.), butane (6 per cent.), and hydrogen (5 per cent.). When a tube of ethyl iodide is exposed to the arc spectrum, the reaction commences only for wave-lengths shorter than 0·41 μ.—R. **Locquin** and L. **Leers**: Some new pinacolines—Max and Michel **Polonovski**: Tautomerism of eserine.—Ph. **Négris**: The variation of composition of lavas and the temperature of the pyrosphere.—J. **Thoulet**: Local studies of the circulation of the water in the Atlantic Ocean.—L. **Petitjean**: The application of frontology to the Sahara depressions.—Filippo **Eredia**: The secondary depression of the Adriatic Sea.—Jules **Wolff**: New observations on the loss of the germinating power in the seeds of orchids.—A. **Sartory** and R. **Sartory**: The action of potassium bichromate and copper bichromate on the growth of *Phytophtora infestans*. The copper salt acts more powerfully than the potassium salt in retarding the growth of this organism.—A. **Goris**: The chemical composition of the green fruit of the vanilla and the mode of formation of the perfume of vanilla.—A. **Demolon** and Mlle V. **Dupont**: Some characters of the peat from the chalk valleys of the north of France.—Ch. **Brioux**: Saturation in the soil of sulphuric acid utilised for the destruction of weeds. After this treatment, soils originally acid or containing only small amounts of lime should be limed, or the soil will be left too acid for plant growth.—Louis **Lapicque**: The theory of latent addition.—Boris **Ephrussi**: The segmentation velocities of the egg of the sea-urchin.—F. **Vlès** and A. **de Coulon**: The relations between the state of the organism and the physico-chemical properties of muscular substances.—Jules **Auclair**: The probable cause of the natural immunity of birds towards human tuberculosis and its application to the digestion of the Koch bacillus in the organism of the guinea-pig. A substance has been extracted from the organism of the pigeon, chicken, duck, goose, and turkey which, as extracted, is without action on the Koch bacillus. Under well-defined conditions this substance can be converted into another capable of digesting the tubercle bacillus. No tuberculosis developed in guinea-pigs, if this substance and the Koch bacillus were injected together. No details of the method of extraction, nature of the substance or mode of after-treatment are given.—L. **Hugounenq** and J. **Loiseleur**: The catalytic action exercised by some colloids, more particularly by glycogen, in the hydrolysis of the albumens.

CAPE TOWN.

Royal Society of South Africa, May 21.—Dr. A. Ogg, president, in the chair.—R. F. **Lawrence**: South African spiders. Several genera of South African Thomisidæ illustrate imitations of the calyx, leaves and leaf-axils of flowers and the stems of reeds and grasses. Runcinopsis is much flattened and lies pressed against the stems of grasses, while the straw-coloured form Monoeses has the abdomen elongated into a long cylindrical caudiform process and escapes observation by remaining motionless amongst grass or thin reeds.—F. G. **Cawston**: The smaller South African shells that harbour Cercariæ.—F. E. **Fritsch** and Florence **Rich**: Contributions to our knowledge of the Freshwater Algæ of Africa, V. On a deposit of diatomaceous earth from Ermelo, Transvaal. This deposit occurs as a pan, about half a mile long and 440 yards wide, on the farm Bank-Plaats, and is still being formed. During the wet season, water percolates through the deposit, and living diatoms are found on its surface; in the dry season these mostly die off, and their siliceous valves form the deposit. Seventeen species of diatoms occur in it; one of these is new, and several new varieties are also described and figured.

MELBOURNE.

Royal Society of Victoria, March 13.—Prof. T. H. Laby in the chair.—A. M. **Lea**: On some new Australian Chrysomelidæ.—F. **Chapman** and F. A. **Singleton**: A revision of the Kainozoic species of Glycymeris in Southern Australia. Three new species are here described, namely, *G. gunyoungensis* (Balcombian and Janjukian), *G. ornithopetra* (Janjukian), and *G. planiuscula* (Kalimnan and Werrikooian). An example of the type referred by McCoy to "*Pectunculus*" *laticostatus* shows that two species were represented. The species described by Johnston as "*Pectunculus*" *maccoyi*, from Table Cape, is apparently confined to that locality, and all Victorian records under that name are here referred to other Victorian species. On broad lines the phylogeny of the group in two main series can be traced, linking the early Kainozoic with the living species.—H. **Ashton**: Notes on the Gippsland hairy cicada, *Tittigarcta crinita*, Dist. This insect, unlike the other Cicadidæ, is probably nocturnal, as it flew late in the evening and early in the morning, and was not seen during the day, hiding under bark. The species is not so uncommon as the small series in the various museums would suggest, as on the evidence of the nymphal cases very many must emerge during the season. The specimens were caught close around the Hotel Kosciusko, and are the first recorded from New South Wales.—G. F. **Hill**: Notes on Australian mosquitoes, with descriptions of their early stages.—H. W. **Wilson**: Studies on the transpiration of some Australian plants, with notes on the structure of their leaves. So long as the available water supply was adequate, the transpiration rate increased with the temperature to the limit of the transpiring power of the plant and increased very rapidly when the temperature rose above normal. The highest transpiration rates recorded in grams per sq. metre per hour for the two hottest days of observation were:—*Eucalyptus botryoides*, 750 gm. between 12 and 2 P.M.; *E. cladocalyx*, 640 gm. between 12 and 2 P.M.; *Casuarina Luehmanni*, 525 gm. between 2 and 3 P.M. Strong wind increased the transpiration of such plants as *E. cladocalyx* and *Casuarina Luehmanni*. The acacias were affected very little, while in other species the transpiration was quite disorganised. Stomata were studied in their relations to transpiration. The number per sq. mm. of transpiring surface varied: *Hakea gibbosa* with 70, and *Myoporum insulare* with 80 had the lowest record, while *Casuarina Luehmanni* with 500, *Eugenia Smithii* with 540, and *Veronica Dieffenbachii* with 610 had the highest average records. The highest records of stomata were 1030, 970, and 960 per. sq. mm. on some juvenile leaves of *Eucalyptus globulus* and 740 on some leaves of *E. cladocalyx*. The size of the stomata varied from 52 × 36 microns (outside measurements) in *Hakea gibbosa*, and 70 × 65 microns in the adult *E. alpina*, to 18 × 16 microns on the juvenile leaves of *E. maculata* var. *citridora*. The so-called xerophytic plants of Australia are provided with a high average number of stomata which enables their transpiration rate to respond quickly to changes of temperature and water supply, and they are well protected by their tough outer coverings, in some cases assisted by glands, from injurious loss of water.

SYDNEY.

Linnean Society of New South Wales, April 30.—Mr. R. H. Cambage, president, in the chair.—W. F. **Blakely**: The Loranthaceæ of Australia (Pt. v.). Six species were described as new.—G. H. **Cunningham**: A critical revision of the Australian and New Zealand species of the genus Secotium. Sixteen species are discussed, fourteen of them being confined to Australasia. Five species are described as new.—P. **Brough**: Studies in the Epacridaceæ. i. The life-history of *Styphelia longifolia* (R.Br.). An explanation of the structure and mechanism of dehiscence of the anther is given, and megasporogenesis is described; the micropylar megaspore functions, in place of the usual chalazal one. All three non-functional megaspores persist in an active state until endosperm formation is almost completed. This phenomenon has not previously been recorded in the life-history of the Angiosperm. The persistence of the non-functional megaspores evidently represents the retention of an ancestral condition, but the present-day function seems to be haustorial.—Marguerite **Henry**: A monograph of the freshwater Entomostraca of New South Wales. Pt. iv. Phyllopoda. Nineteen species are given, six of which are described as new, while three others are recorded for the first time from New South Wales and one from Australia.

Official Publications Received.

Uganda Protectorate. Annual Report of the Geological Survey Department for the Year ended 31st December 1923. Pp 11. (Entebbe, Uganda: Government Printer.)

Canada: Department of Mines. The Mineral Industries of Canada. Compiled by A. H. A. Robinson. (British Empire Exhibition edition, 1924.) Pp. 138. (Ottawa. Government Printing Bureau.)

South African Museum. Guide Leaflet No. 1. Inscriptions left by Early European Navigators on their Way to the East. By L. Péringuey. Pp. 49. (Cape Town.)

New York Zoological Society. Report of the Director of the Aquarium for 1923. Pp. 16. (New York City.)

New York Academy of Sciences. Scientific Survey of Porto Rico and the Virgin Islands. Vol. 5, Part 3 Botany of Porto Rico and the Virgin Islands. Descriptive Flora—Spermatophyta (continued) By N. L. Britton and Percy Wilson. Pp. 317-474. (New York City.) 2 dollars.

Madras Fisheries Department. Administration Report for the Year 1922-23 By James Hornell. (Report No. 1 of 1924, Madras Fisheries Bulletin, Vol. 18.) Pp 58. (Madras. Government Press.) 10 annas.

South Australia: Department of Mines. Mining Review for the Half-year ended December 31st, 1923. (No. 39.) Pp. 83. (Adelaide: R. E. E. Rogers.)

City and Guilds of London Institute. Report of the Council to the Members of the Institute, 1924. Pp. li+97. (London: Basinghal Street, E.C.2.)

Instituts scientifiques de Buitenzorg "'s Lands Plantentuin." Treubia: Recueil de travaux zoologiques, hydrobiologiques et océanographiques. Vol. 5, livraison 4, avril. Pp. 299-434. (Buitenzorg: Archipel Drukkerij.) 2 50 f.

The Journal of the Royal Anthropological Institute of Great Britain and Ireland. Vol. 54, January to June 1924. Pp. 209+32 plates. (London: 50 Great Russell Street, W.C.1.) 15s. net.

Supplement to NATURE

No. 2858 AUGUST 9, 1924

Prevention of Disease.[1]

By Major-General Sir DAVID BRUCE, K.C.B., F.R.S., A.M.S., President of the British Association.

THIS is the fourth time the British Association for the Advancement of Science has met in Canada—first in 1884 in Montreal, in this city in 1897, and in Winnipeg in 1909. The addresses given on these occasions dealt with the advancement of knowledge in archæology and physics. It is now my privilege, as a member of the medical profession, to address you on the advances made during the same period in our knowledge of disease and our means of coping with and preventing it.

An address on the prevention of disease at first sight does not promise to be a very pleasant subject, but, after all, it is a humane subject, and also a most important subject, as few things can conduce more to human happiness and human efficiency than the advancement of knowledge in the prevention of disease. Think for a moment of the enormous loss of power in a community through sickness. Some little time ago the English Minister of Health, when emphasising the importance of preventive work, said that upwards of 20,000,000 weeks of work were lost every year through sickness, among insured workers in England. In other words, the equivalent of the work of 375,000 people for the whole year had been lost to the State. When to that is added the corresponding figure for the non-insured population you get some idea of the importance of preventive work.

Another way of estimating the value of prevention is in terms of dollars, or pounds, shillings, and pence, and it has lately been calculated that the direct loss in England and Wales from sickness and disability amounts to at least 150,000,000*l.* a year. In the United States, with a much larger population, the loss is put down at 600,000,000*l.*

Another reason why this is an important subject is that medicine in the future must change its strategy, and instead of awaiting attack must assume the offensive. Instead of remaining quietly in the dressing stations and field hospitals waiting for the wounded to pour in, the scientific services must be well forward in the enemy's country, destroying lines of communication, aerodromes, munition factories, and poison-gas centres, so that the main body of the army may march forward in safety.

It must no longer be said that the man was so sick he had to send for the doctor. The medical practitioner of the future must frequently examine the man while he is apparently well, in order to detect any incipient departure from the normal, and to teach and urge modes of living conformable to the laws of personal health, and the Public Health authorities must see to it that the man's environment is in accordance with scientific teaching. It may be a long time before the change is widely accepted, but already enormous advances have been effected, and it only depends on the intelligence and education of the populations how rapid the future progress will be. Public opinion must be educated to recognise that most diseases are preventable and to say with King Edward VII., "If preventable, why not prevented?"

To our forefathers disease appeared as the work of evil spirits or magicians, or as a visitation of Providence to punish the individual or the community for their sins. It is not my purpose to give a detailed account of the first strivings after a better knowledge of the causes of disease, but it may be said the new era began some few hundred years ago, when it was recognised that certain diseases were contagious. For a long time it was held that this contagion or infection was due to some chemical substance passing from the sick to the healthy, and acting like a ferment; and then, about the middle of last century, the idea gradually grew that microscopic creatures might be the cause.

About this time it had been discovered that the fermentation of grape juice was caused by a living cell and that certain contagious skin-diseases were associated with living fungi. Things were in this position when there appeared on the scene a man whose genius was destined to change the whole aspect of medicine; a man destined to take medicine out of the region of vague speculation and empiricism, and set its feet firmly on new ground as an experimental biological science. I mean the Frenchman, Louis Pasteur. It is from him we date the beginning of the intelligent, purposive prevention of disease. It was he who established the germ theory, and later pointed the way to the immunisation of man and animals, which has since proved so fruitful in measures for the prevention or stamping out of infectious diseases. I need not discuss his life and work further. His name is a household

[1] Inaugural address delivered to the British Association at Toronto on August 6.

word among all educated and civilised peoples. Every great city should put up a statue to him, to remind the rising generations of one of the greatest benefactors of the human race.

What the change in medicine has been is put into eloquent language by Sir Clifford Allbutt: "At this moment it is revealed that medicine has come to a new birth. What is, then, this new birth, this revolution in medicine? It is nothing less than its enlargement from an art of observation and empiricism to an applied science founded upon research; from a craft of tradition and sagacity to an applied science of analysis and law; from a descriptive code of surface phenomena to the discovery of deeper affinities; from a set of rules and axioms of quality to measurements of quantity."

With one notable exception, the medical profession were not quick to see that Pasteur's discoveries of the nature of fermentation and putrefaction had a message for them. This exception was Joseph Lister, who had been for some years endeavouring to comprehend the cause of sepsis and suppuration, which commonly followed every surgical operation and most serious injuries involving a breach of the skin. When, in 1865, Lister read Pasteur's communication upon fermentation, the bearing of the discovery on the problems which had so earnestly engaged his attention was apparent to him. He inferred that suppuration and hospital gangrene, the causes of which had so far baffled his imagination, were due to microbes introduced from the outside world, from the air, and by instruments and hands of the operator. Remember, this was years before the microbial causation of any disease was established.

To test the correctness of his inference, Lister proceeded to submit all instruments, ligatures, materials for dressings, and everything that was to come directly or indirectly into contact with the wound, the hands of the operator, and the skin of the patient, to treatment with chemical disinfectants. The satisfactory results which followed this practice astonished even Lister, and he spent the rest of his active life in improving and simplifying technical methods of preventing the ingress of microbes to wounds, and in convincing his professional brethren of the truth of the conclusions based on this work of Pasteur.

Infectious Diseases—(A) Bacterial.

As soon as it was recognised that infectious diseases are caused by living germs, a wave of enthusiasm swept through the medical world, and it was not long before the causation of many of the most important of them was discovered. I need not give a full list of these, but at or round about the time of the first meeting of the British Association in Canada the micro-organisms of tuberculosis, typhoid fever, Malta fever, cholera, malaria, diphtheria, tetanus, and others had been discovered and described.

But it must not be assumed from what has been said that all the most important diseases are caused by living germs. Many of the ills that afflict mankind are due to quite other causes—alcoholism, for example, or the deficiency diseases, due to the absence or deficiency in our diet of some substance essential to proper growth and development. Rickets, one of the greatest scourges of industrial communities, is mainly a deficiency disease. It is reported that as many as 50 per cent. of the children in the slums of some of our big cities suffer from the effects of this disease. Then, again, there is the whole series of diseases or conditions due to defective or excessive action of our own internal glands. Added to these, and perhaps the greatest scourge of all, there is the immense amount of chronic ill-health and actual disease caused or promoted by the unhealthy conditions found in our large cities, due to bad housing and overcrowding—the so-called diseases of environment.

Malta Fever.

To return to the infectious diseases. After the living germs or parasites causing them had been isolated, the process of prevention was soon begun. The methods employed were varied, and I may illustrate one of the simplest by relating briefly the history of the prevention of Malta fever, with which I was myself, to some extent, associated. Malta fever is really a widespread disease, although it is called by a local name. It is found all round the Mediterranean, throughout Africa as far south as the Cape Province, in India and China, and even in some parts of America. It was very prevalent in Malta in the old days, and rendered the island one of the most unhealthy of all our foreign military stations. When I arrived in Malta, in 1884, I found that every year, on an average, some 650 soldiers and sailors fell victims to it, and, as each man remained on an average 120 days in hospital, this gave the huge total of about 80,000 days of illness per annum from this fever alone.

The British had held Malta since the beginning of last century, and, although much attention had been given to the fever and its symptoms had been fully described, no advance was made towards its prevention until 1887, when the living germ, the *Micrococcus melitensis*, causing it was discovered. At this time a good deal of work was expended in studying the natural history of the fever and the micrococcus, but all to no purpose. Nothing was discovered to give a clue to any method of prevention. At the Naval Hospital especially everything in the way of prevention was done that could be thought of: the water supply and drainage were thoroughly tested, the walls were scraped and every corner rounded off where dust might lie, immaculate cleanliness reigned; but all these pre-

cautions proved useless. Almost every sailor who came into the hospital even for the most trivial complaint took Malta fever, and after a long illness had to be invalided to England.

Things remained in this very unsatisfactory state for seventeen years, until 1904, when the Admiralty and War Office, alarmed at the amount of sickness and invaliding in the Malta garrison, asked the Royal Society of London to undertake the investigation of the fever. This was agreed to, and a Commission was accordingly sent out in the same year and remained at work until 1906. During the first year every likely line of approach was tried. A careful study was made as to how the micrococcus entered the body, how it left the body, its behaviour outside the body, its pathogenic action on various animals; but still no indication of a method of prevention showed itself. Next year, however, in 1905, the problem of prevention was solved, and that by the merest of accidents.

In the previous year experiments had been made with the object of finding out if the goat, among other animals, was susceptible to the disease. The goats in Malta, which supply all the milk, are very much in evidence, as they are driven about in small herds and milked as required at the doors of customers. Several goats had been injected with cultures of the micrococcus, but, as they showed no rise of temperature or any signs whatever of ill-health, they were put aside as being immune or refractory to the disease and nothing more was thought about them.

In the spring of 1905, about six months after these experiments had been made, Dr. Zammit, a Maltese member of the Commission, who had kept one or two of these goats, happened for some reason or other to examine their blood, and found that it clumped or agglutinated the micrococcus. This was strange, and seemed to show that, although the micrococcus had not caused fever or any signs of illness in the goats, it must have lived and multiplied in the tissues of these animals in order to have brought about this change in the blood. This observation led to the re-examination of the immunity of the goat, when the extraordinary discovery was made that about 50 per cent. of the goats in the island were affected by this disease, and that 10 per cent. of them were actually excreting the micrococcus of Malta fever in their milk. Monkeys fed on milk from an affected goat, even for one day, almost invariably took the disease.

Thus the weak link in the chain of causation had been found. The military authorities struck Maltese milk out of the dietary, and replaced it by an imported variety, and from that day to this there has scarcely been a case of Malta fever in the garrison. Malta, from being the most unhealthy of foreign stations, became a health resort, and was in fact used as a sanatorium during the late War. The disease had been blotted out at a single blow. This, then, is one way of preventing an infectious disease; that is to say, by the discovery of the living germ, the study of its natural history, and so to a means of stopping it reaching its victim, man. This is the best way of prevention: shutting the stable door before the horse is stolen.

Typhoid Fever.

There are, however, other ways of preventing bacterial diseases. Let us take, for example, a method widely used in the prevention of typhoid fever. The fundamental and sound way of attacking this disease is by ordinary hygienic measures, especially a good water supply and good drainage. It is therefore one of the first duties of those in power to see that their people have, in addition to houses with plenty of light and air, a good water supply and a good drainage system, and money cannot be spent to better advantage than in the attainment of these three essentials to health.

When typhoid fever is rife in a community, it means that there is either a contaminated water supply or a faulty drainage system, and the municipal authorities ought to be called to account. In England, owing to improved sanitation, cases of typhoid fever are fifteen times less than they were fifty years ago.

It is not always possible to ensure good hygienic surroundings—for example, among troops on active service. It is therefore legitimate under certain conditions, and especially in time of war, to practise a less sound, a less fundamental, method of prevention, and this second method is known as inoculation or vaccination. In order to understand how this acts, let us consider, for a moment, what takes place in a man's body when he is attacked by the typhoid bacillus. Everybody knows that the bacillus gives rise to poisons or toxins which cause the fever and other symptoms. But the cells and tissues of the man are not passive under the attack. They at once begin to fight against the infection, by forming substances in the blood to neutralise these toxins, hence called antitoxins or antibodies, and their function is finally to destroy the invading germs. If the man recovers, he is immune from a further attack by the presence of these antibodies in his blood. He has become immune by passing through an attack of the disease.

This is the foundation of the second way of preventing infectious diseases. Speaking broadly, it means that you subject a man to a mild attack of the fever in order that his blood and tissues will respond to the stimulus by producing antibodies. This method takes its origin and name from that of vaccination against smallpox. Jenner solved that problem by the accidental discovery of vaccinia, a form of smallpox attenuated or weakened by passage through another species of animal. This weakening of the virulence of a micro-

organism by passage through another kind of animal is by no means uncommon in Nature.

Pasteur, following on these lines, conceived the idea of weakening or attenuating the virulence of the living bacilli by artificial means, so as to give rise to a mild attack of the disease, and in this way to render animals immune. This he did with marked success in anthrax and chicken cholera.

The next forward step in this method of preventing disease was made by Haffkine, a pupil of Pasteur, who about the year 1894 produced a vaccine against cholera, and a few years later another against plague. In the course of this work it was discovered that it was not necessary to use living cultures of the bacilli, but that vaccines made up of dead bacilli had much the same effect. This substitution of the dead bacilli for the living was a great advance in the method, being much simpler and much safer.

The next disease to be attacked by this method was typhoid fever. This was initiated by Sir Almroth Wright at the British Army Medical School, and carried out with that investigator's characteristic ability and energy. The method was mainly directed in the first place to lessen the mortality from this disease among our soldiers serving in India. After several years' experience, the mode of inoculation which was finally settled on was to give two injections of dead typhoid bacilli, one of 500 millions, and a second, at an interval of ten days, of a thousand millions.

Now let us see what effect anti-typhoid inoculation has had on the prevention of typhoid fever among our soldiers in the field. In the South African War, at the beginning of the century, before the method had been developed, in an army the average strength of which was only 208,000, there were 58,000 cases of typhoid fever and 8000 deaths. In the Great War, on the Western Front, with an average British strength of one and a quarter millions, there were only 7500 cases and 266 deaths. In other words, there were fewer cases of the disease in this War than there were deaths in the South African.

It is also interesting to learn from French sources that at the beginning of the War the French soldiers were not inoculated, whereas the British were. The result for the first sixteen months was striking. During this time the French had some 96,000 cases, with nearly 12,000 deaths. The British had only 2689 cases and 170 deaths. Afterwards the French soldiers were very thoroughly vaccinated, with the result that their immunity eventually became as striking as our own.

What the number of cases and death-rate from typhoid fever might have been in the huge armies fighting on the different fronts had it not been for this preventive inoculation it is impossible to say, but undoubtedly the suffering and loss of life would have been enormous. I may therefore conclude this account of anti-typhoid inoculation by saying that it certainly constituted one of the greatest triumphs in the prevention of disease during the recent War.

Tetanus and Diphtheria.

I shall now pass on to consider a third method of preventing bacterial diseases which has also been evolved during the time under review; that is, by the injection of specially prepared blood sera. These are known as antitoxic sera, and the most familiar examples are anti-tetanic and anti-diphtheritic.

We have seen how the injection of living or dead bacilli or their toxins into animals gives rise to the production of antibodies or antitoxins. The blood serum of such animals in virtue of the antibodies contained in it can be used to combat disease. Let us take in the first place the case of tetanus, until recently considered to be one of the most fatal of maladies, at least 85 per cent. of the cases succumbing. As you are aware, anti-tetanic serum is prepared by injecting horses with large quantities of tetanus toxin. When the blood is as full as possible of antibodies, it is drawn off and the serum allowed to separate out.

The idea lying behind this third method of preventing disease is to pour in these ready-made antitoxins in order to assist the body in its first struggle with the invading disease, and give it, as it were, a breathing space to prepare its own defences. Naturally the immunity produced by these antitoxic sera is of a passive nature and of short duration, as compared with that produced by the disease itself, or even by the milder form brought about by vaccination or inoculation. Anti-typhoid inoculation will protect a soldier for, let us say, two years; anti-tetanic serum will protect for only a week or ten days. It is therefore impossible to inoculate a whole army against tetanus. It is necessary to wait until there is a danger of the disease occurring.

To illustrate this I shall describe briefly the history of the prevention of tetanus during the Great War. When the British Expeditionary Force went over to France in August 1914, only a small quantity of anti-tetanic serum was taken, and that for the purpose of treatment rather than prevention. But shortly after the outbreak of hostilities, the number of cases of tetanus among the wounded became so alarming that no time was lost in grappling with the danger. Large quantities of serum were hurried to the front, and some two months after the beginning of the War it was possible to make an order that every wounded man should receive an injection of anti-tetanic serum as soon after he was wounded as possible. Later on, after further experience had been gained, the single injection was increased to four, given at intervals of a week. This helped the wounded man over the dangerous time, and the results were very successful.

In August and September 1914, before the prophylactic injection was given, roughly speaking, nine or ten out of every thousand wounded were attacked by tetanus, and some 85 per cent. of these died. After the anti-tetanic injections had been introduced, the incidence fell to little more than one per thousand, and the mortality to less than half. To put the matter broadly: during the War there were 2500 cases of tetanus in the British Army, with 550 deaths. If there had been no prophylactic injection of anti-tetanic serum, there would probably have been 25,000 cases with 20,000 deaths—a very striking example of the recent development in the prevention of disease.

Another very important and widespread disease, somewhat resembling tetanus, is diphtheria, and there is no better example of the advance of science in methods of cure and prevention than is found in this disease. Thanks to the work of Klebs and Löffler in the early 'eighties and, some years later, to the brilliant researches of Roux and Yersin, the causation and natural history of this disease were very thoroughly elucidated. Anti-diphtheritic serum is prepared much in the same way as the anti-tetanic. By the repeated injections of gradually increasing doses of the bacilli or their toxins, a serum is produced which has a marked curative effect in cases of diphtheria. It is stated that the introduction of anti-diphtheritic serum in 1894 has reduced the death-rate from 40 to 10 per cent., and if used on the first day of the disease to almost *nil*.

The serum is essentially a curative agent and is useful only to a limited extent in prevention. But lately essentially preventive measures in diphtheria have come into vogue. The procedure employed is to bring about an active immunisation by a mixture of toxin and antitoxin in individuals who have been shown to be susceptible to the disease by what is known as the Schick test. In the United States, a campaign on these lines has been begun against this disease which promises brilliant results. It is confidently stated that by their new measures there is a possibility of robbing diphtheria of all its powers to kill or injure.

The mode of prevention of these diseases—Malta fever, typhoid fever, and tetanus—illustrates the three principal methods of preventing bacterial diseases: in Malta fever, by getting down to bed-rock and stopping the disease at its source; in typhoid fever, by giving, as it were, a mild attack of the disease, by vaccination or inoculation, so as to bring about a greater power of resistance; in tetanus, by pouring in antitoxins, already prepared in the serum of another animal, in order that they may neutralise the toxins of the invading bacilli as soon as they are formed.

Tuberculosis.

There are other important bacterial diseases, however, which cannot be attacked so simply. For example, there is tuberculosis, a disease distributed over the whole world and one of the greatest scourges of civilised communities. It is a disease which has been known from time immemorial, but it is only within our own time that the bacterial cause has been recognised. I can well remember a day in 1882 when I met a fellow student who had just returned to Edinburgh from Germany. He told me that it had been recently discovered that the disease was really caused by a living germ, the tubercle bacillus. It was difficult at first to believe such a revolutionary idea, but such was the interest and excitement raised that many workers at once took up the study of the subject, and in a short time the truth of Koch's great discovery was fully proved. This was a magnificent example of research work, most admirably, carefully, and completely carried out, and placed Koch at once in the front rank of scientific workers.

Before Koch's discovery a good deal had been done in the way of prevention. Before all things, this disease is a disease of environment. Its birthplace and home is the sunless, ill-ventilated, overcrowded room. The late Prof. Edmund Parkes, Professor of Hygiene at the Army Medical School, reduced to a great extent the incidence of tuberculosis in the British Army by procuring for the soldier more floor-space and more air-space in his barracks. It is related of General von Moltke that when he heard of the death of Parkes he said that every regiment in Europe should parade on the day of his funeral and present arms in honour of one of the greatest friends the soldier ever had.

The prevention of tuberculosis is thus seen to depend fundamentally on the provision of a better environment and the education of the people in physiological living. To attain this in the older civilisations will be a hard task, entailing enormous expenditure of money and energy. In the Report of the Royal Commission on the Housing of the Industrial Population of Scotland in 1917 is described the unsatisfactory sites of houses and villages, insufficient supplies of water, unsatisfactory provision for drainage, the gross overcrowding in the congested industrial towns, occupation of one-room houses by large families, groups of lightless and unventilated houses in the older burghs, clotted masses of slums in the great cities—a terrible picture, the heritage of the age of ignorance, internal strife, and walled towns.

The people of new countries should see to it, and doubtless will see to it, that these old evils are not perpetuated. As Sir Robert Philip, Professor of Tuberculosis in the University of Edinburgh, has eloquently said: "Were it possible to begin afresh the scheme of civilised life, were it possible to undertake anew the creation of cities and the homes of our people, were it possible to place within the recreated dwellings an

understanding race, detuberculisation might be quickly attained. What a magnificent opportunity for the builders of the new cities, the moulders of fresh civilisations, with the grand purpose of 'No tuberculosis.' The architect, the sanitarian, and the citizen would agree in insisting that physiological laws should be paramount, that there should be effective obedience to the larger demands of hygiene in the home, the school, the workshop, the meeting-place and the cowshed. Mankind was born into air and sunlight: these are his natural heritage. They are more—they are the irreducible conditions of life."

In regard to the tubercle bacillus it is so widespread, so ubiquitous in civilised communities, passing from one infected host to infect another, that it would seem impossible under existing conditions to prevent its spread. At present it is taught, and on what seems good evidence, that the majority of the population of our crowded cities has at one time or another been attacked by this disease. But in every hundred men who die in England, only about ten die of tuberculosis, which shows that a large percentage of the population successfully resists the tubercle bacillus. When this occurs it means that the person attacked possessed powers of resistance which enabled him either to destroy the invading bacilli or deal with them so as to render them harmless.

A point of importance in this connexion is that it has recently been demonstrated that the disease is usually acquired in childhood. The fact is of capital significance, for if the disease is recognised sufficiently early, and the child is placed under good hygienic conditions, there is a very good chance of effective resistance and immunity against a second attack being set up. The present evidence goes to show that the presence of latent tubercle prevents a second invasion. If further outbreaks take place, they would seem to be due to a flaring up of the old latent tubercle rather than to a fresh infection. Metchnikoff studied the question in a remote part of Siberia where the tubercle bacillus was unknown. He states that very many of the young men and women who migrated from this clean country into the big cities died of acute and rapid tuberculosis, on account of not having been exposed to infection in their childhood.

The experience of Colonial troops in the late War is instructive. Thus, in France the Senegalese, who are almost without tuberculosis in their native condition, and were found to be free from tuberculosis on reaching France, developed in large numbers an acute and fatal form of tuberculosis in spite of the hygienic measures enforced by the Army authorities. This raises a curious point. If it were possible for any country to clear itself of the tubercle bacillus, it would appear to be incurring a great risk for an inhabitant to migrate into any neighbouring country. But, in spite of this, it is the duty of medical men to keep in check, as far as possible, the ravages of the disease.

The preventive measures against tuberculosis at the present time are, in the first place, improvement in the general hygienic conditions. Thereby individual resistance—and communal resistance—can be remarkably increased. In the second place, as every case of tuberculosis must arise from a previous case, either human or bovine, it is very necessary that methods of early diagnosis, preventive treatment, and segregation of the more infective types should be employed. This is done by the setting up of tuberculosis dispensaries, care committees, sanatoria, hospitals and colonies. These several elements are combined in the model Tuberculosis Scheme which is now universal throughout Great Britain. In the third place, much can be done to anticipate and limit the progress of infection by the use of tuberculin, but caution is required in assessing the claims, sometimes hasty and extravagant, advanced by adventurers in this field of research.

Many other points might be brought forward, but the subject is such a vast one that I must content myself with directing attention to the importance of a sound milk supply. The contamination of our home herds with tuberculosis is so great that no pains should be spared to secure a safe milk supply, and I understand that the city of Toronto is a model in this respect.

The result of these methods of prevention against tuberculosis may be given briefly. Sir Robert Philip writes that in Scotland ten years before Koch's discovery the death-rate from this disease was 404 per 100,000; in 1920 it had fallen to 124 per 100,000, a fall of 69 3 per cent. He also points out that the "recent acceleration of rate of reduction which is noticeable in England and Scotland is of arresting interest. In Scotland the acceleration of fall in the mortality rate likewise arrests attention. Thus, during twenty years up to 1890, the percentage fall in mortality from all forms of tuberculosis was 35, while during twenty years from 1900 to 1919 the percentage fall was 45."

This is very satisfactory, and has only been arrived at by hard work on the part of medical men, nurses, and voluntary workers. Any tuberculosis scheme, however perfect in theory, will require untiring energy, patience, and perseverance to bear fruit. On this side of the Atlantic, in the United States, these anti-tuberculosis schemes have been pursued with enthusiasm, with the result that Washington in 1920 had a death-rate, from all forms of tuberculosis for 100,000 of the population, of only 85, Chicago 97, and New York 126. London in the same year had a death-rate of 127, practically the same as New York. Other nations have not been so energetic in preventive measures, Vienna having in 1920 a death-rate of 405, and Paris 279 per 100,000 from the same cause.

It is evidently the duty of every nation to take up

arms against a disease which exacts such a terrible toll of death, suffering, and inefficiency. If this were done with energy and enthusiasm it is not too much to hope that in a few generations the tubercle bacillus would be practically brought under control, and with it many other malign influences.

Infectious Diseases—(B) Protozoal.

I shall now pass on to the consideration of the second great group of infectious diseases, the Protozoal, and consider what methods of prevention have been found applicable to them.

The scientific study of the protozoal diseases of man may be said to have begun with the epoch-making discovery of the malaria parasites in 1880 by the illustrious Frenchman, Laveran; next, in 1893, the discovery by Theobald Smith and Kilborne of the cause of Texas fever and the part played in its dissemination by the cattle-tick; in 1894 the discovery of the trypanosome of nagana and its intermediate insect host the tsetse-fly; in 1898 the working out of the development of the malaria parasite of birds in the mosquito by Ronald Ross, greatly aided and abetted in the work by Patrick Manson, which led, through the work of Grassi and his fellow-workers in Italy, to the final solution of the malaria problem. A year later the important discovery of the mosquito carrier of yellow fever was made by the American Army Commission, under the directorship of Reed, and in 1903 Leishman announced his discovery of the protozoal cause of kala-azar.

These protozoal diseases are world-wide, like the bacterial, but it is in the warmer climates that their effect is most felt. The great plagues of the tropics, such as malaria, amœbic dysentery, kala-azar, and sleeping sickness among men, Texas fever, tsetse-fly disease, and others among domestic animals, are caused by minute microscopical animal parasites. Large tracts of country have been and are still rendered uninhabitable to white settlers by their presence. The opening up of Africa, for example, was rendered difficult by the tsetse-fly, before the advent of railways. No sooner had an expedition started for the interior than the fly attacked the cattle transport, and before long the expedition had to make its way back as best it could to its base on the coast. The only way to get into the country was on foot with native porters.

The protozoal diseases of domestic animals have also led to enormous loss in all parts of the world. Texas fever, or red-water, has swept whole countries of their cattle. After the Boer War, South Africa was devastated by the introduction of East Coast fever, another protozoal disease of cattle closely related to Texas fever. How is the prevention of these diseases to be brought about? We find that up to the present little can be done by way of vaccination or inoculation or by the use of anti-sera as in the bacterial diseases. On studying the natural history of these protozoal parasites, however, it is found that many of them depend on an intermediate insect host for their continued existence, and it is by taking advantage of this characteristic that methods of prevention can be devised. To illustrate this I might cite the classical examples of malaria and yellow fever, but, as these must be familiar to you all, I shall take instead the trypanosome diseases of Africa, the best known of which are sleeping sickness in man and nagana or tsetse-fly disease in the domestic animals.

Nagana or Tsetse-fly Disease.

In 1894, a year after Theobald Smith and Kilborne had published their famous monograph on Texas fever, a severe epidemic among native cattle in the north of Zululand was reported to the Natal Government. The disease was called nagana by the natives, and it is curious that there was no suspicion at the time that it had any connexion with the tsetse-fly. At this time a very enlightened administrator, the late Sir Walter Hely-Hutchinson, was Governor of Natal and Zululand, and it was due to him that the investigation of the cause of the Zululand outbreak was at once undertaken. As I happened to be stationed in Natal at this time I was chosen to undertake the work, and at once started on the long journey, mostly by ox-wagon, to the scene of the outbreak.

On examination of the blood of the nagana cattle, a minute active flagellated protozoal parasite, belonging to the genus Trypanosoma, was discovered, and after many experiments on dogs, horses, and cattle it was decided that in all probability it was the cause of the disease. Trypanosomes had previously been described in the blood of rats and horses in India by Timothy Lewis and Griffith Evans, but nothing was known as to the mode of their transmission from animal to animal.

It seemed as if the discovery of the nagana trypanosome would have ended the investigation in Zululand without any means of preventing the disease being discovered, but another observation made at this time threw more light on the subject. In the low country, between the high ground on which the nagana camp was situated and the sea, there happened to be a so-called "Fly belt." Every schoolboy had read about the tsetse-fly in books of travellers and hunters, especially in those by the most famous of them all, David Livingstone the missionary, and out of curiosity I decided to find out what happened when an animal was bitten by the fly, or, as it was termed, fly-struck. Natives were therefore sent with cattle and dogs into this "fly country," with orders to form a camp and expose the animals to the bites of the fly. This was done, and it was with great surprise that on their

return to the hill the blood of these fly-struck animals was found to contain the same parasite as that found in the nagana cattle.

Nagana and tsetse-fly disease were finally proved to be identical. The tsetse-fly disease was shown to be caused, not, as had been believed, by the poisonous bite of the fly, but by the transference of a protozoal parasite from the fly to the animal in the act of sucking blood. Now the question arose as to where the fly found the parasite. As the tsetse-flies constantly lived among and fed on wild game, such as buffalo and antelope, these animals were suspected. Their blood was examined, and before long it became evident that the wild animals acted as the reservoir of the disease, the trypanosomes living in their blood as harmless parasites. When the tsetse-fly fed on blood containing the trypanosome it became infected, and was capable by its bite of giving rise to a fatal disease in cattle, horses, or dogs; whereas if it fed on a wild animal nothing happened, as the wild game are immune to the disease, much in the same way as the goat is immune to Malta fever.

Now that the natural history of the disease had been so far worked out it was evident that its prevention might be attempted. This can be done in any of three ways: by getting rid of the wild game, the reservoir; or by getting rid of the fly, the vector or carrier; or, lastly, by removing the cattle, horses, and dogs to a safe distance from the "fly country." This work on nagana led later, in 1903, to the discovery of the cause and mode of prevention of sleeping sickness.

Sleeping Sickness.

About the beginning of the century an epidemic of this disease raged round the shores of Lake Victoria in Central Africa. It had been introduced into Uganda from the West Coast, where it had been known for many years as a curious and unaccountable disease. It was observed that although the disease spread in a West African village from man to man apparently by contact, no such thing occurred among natives exiled from their homes. The disease never spread if introduced into native compounds in the West Indies or America, however closely the slaves might be herded together. The disease remained shrouded in mystery, and nothing had been done in the way of prevention, until the matter was taken up by the Royal Society of London in 1902 and a Commission sent out to investigate. It is not necessary to go into details; suffice it to say that after one or two false starts the Commission in 1903 came to the conclusion that the disease was caused, as in nagana, by a species of trypanosome.

The question of the distribution of sleeping sickness in Uganda was then taken up. This disclosed the remarkable fact that the disease was restricted to the numerous islands in the northern part of the lake and to a narrow belt of country skirting the shores of the lake. In no part of Uganda were cases found more than a few miles from the lake shore. The next important step in the working out of the etiology was made when it was shown that the distribution of the disease was identical with the distribution of the common tsetse-fly of the country, *Glossina palpalis*. Where there was no fly there was no sleeping sickness.

The problem was now solved. The epidemic could be stopped either by getting rid of the fly or by removing the natives out of the fly area. As the destruction of the fly was impracticable under the circumstances, the second method was decided on. The natives were moved from the islands and lake shore and placed on healthy inland sites, and the epidemic, which had cost the Protectorate some 200,000 lives, speedily came to an end.

This method of preventing disease, by removing man out of the zone of danger, is an extravagant one, and can only be done in exceptional circumstances. In Uganda the native population could be easily moved, but it meant that from about 1910 until the present day some of the most fertile land in Uganda has been lying derelict, has returned to the primitive jungle. The War delayed things, of course, but it is only now that the natives are being returned to their old homes on the islands and lake shore, in the hope that the fly by this time has lost its infectivity.

The other method, by the destruction of the tsetse-fly, has been carried out successfully in other places. For example, in the island of Principe, off the West Coast of Africa, by destroying the wild animals which supplied a large part of the food of the fly and by clearing the jungle, the tsetse-flies disappeared, and with them the disease. This is the method employed in malaria and yellow fever. It was by destroying the mosquito carrier that Gorgas drove yellow fever out of Havana and, later, both malaria and yellow fever from the Panama Canal zone. Thus through the work of Manson, Laveran, Ross, Reed, and others has it been made possible to deal with these two scourges of the tropics, malaria and yellow fever. I include yellow fever among the protozoal diseases, although Noguchi in 1919 brought forward strong evidence that it is caused by a spirochæte.

In regard to yellow fever the victory has been almost won. During the last century this disease, known as "yellow jack," devastated the West Indies and Central and South America. At the present time, thanks chiefly to the unremitting efforts of the late General Gorgas and the International Health Board of the Rockefeller Foundation, the disease has been driven out of the West Indies and Central America, and only retains a precarious foothold in Colombia and Brazil, whence it will doubtless be ejected during the next year or two.

One of the best examples of the prevention of disease is the attack made on yellow fever in Rio de Janeiro, the capital of Brazil, by the well-known man of science, Dr. Oswaldo Cruz, with the result that the annual deaths in the city from yellow fever fell from 984 in 1902 to 0 in 1909. This brilliant result was brought about by the destruction of the Stegomyia mosquito, the intermediate insect host in yellow fever.

So also in the case of malaria. A dozen years ago, based on the experience gained by Ross on the West Coast of Africa and Ismailia and by Watson in the Federated Malay States, the method of prevention by mosquito control and drainage has been so perfected that the practical blotting out of malaria from a given locality is now merely a matter of expense. A great deal of work has been done during the last few years in the way of experiment in the United States, and Vincent, the President of the Rockefeller Foundation, lately stated that there is evidence that "under normal conditions an average community can practically rid itself of malaria at a *per capita* cost of from 45 cents to $1 per year."

This is an altogether inadequate account of the methods of preventing these highly important protozoal diseases. From the few examples given it will be seen that they are most rampant in warm climates, that they are as a rule conveyed from the sick to the healthy by an insect intermediary, and that it is by an attack on this insect, be it mosquito, tsetse-fly, or tick, that the best chance of success in prevention lies.

Infectious Diseases—(C) Undetermined Group.

In addition to the bacterial and protozoal infectious diseases, there is a third and large class, known as the "undetermined group," in which the parasite is either unknown or doubtful. Many of these undetermined diseases are very common and familiar, such as influenza, measles, scarlet fever, smallpox, typhus fever, trench fever, dengue fever, and sand-fly fever; among animals, rabies, rinderpest, foot-and-mouth disease, and African horse-sickness. The theory generally held at present in regard to most diseases included in this group is that the living germs causing them are ultra-microscopical, in at least some part of their life history, and this is strengthened by the fact that many of them pass through porcelain filters, which keep back the smallest of the visible bacteria. Hence the name "filter-passers."

Many of these undetermined diseases are highly infectious and appear to infect at a distance through the air, as, for example, in influenza, scarlet fever, and smallpox. In some of them there is no attempt made at prevention, except that the sick are isolated and placed under quarantine for a longer or shorter period. But in others there are well-known methods of prevention even when the virus is quite unknown. The best example is smallpox, the ravages of which have been completely held in check since the memorable discovery of Jenner. As has already been argued, this method of prevention, by inducing a mild or attenuated form of the disease, is at best a clumsy one, and when the natural history of the smallpox virus is better known it may be hoped that a more fundamental method of preventing this disease may be discovered. In the meantime the best means at our disposal is by the use of vaccine lymph, and people should recognise their responsibility to the community if through ignorance or selfishness they refuse to have their children vaccinated.

Another well-known disease with an unknown virus, rabies or hydrophobia, has also, by the genius and intuition of Pasteur, been robbed of many of its terrors. The mortality following bites of rabid animals has fallen from 16 per cent. to less than 1 per cent. But in rabies, when the conditions are favourable, the radical method is to drive the disease altogether out of the country by the careful administration of muzzling and quarantine laws. This was carried out successfully in England at the beginning of the century.

Trench Fever.

There are among the diseases of undetermined origin a few which are slowly emerging from the unknown into the known. One of the most interesting of these is trench fever, which came into great prominence during the War. The history of the investigation of this fever is interesting, and well illustrates the method of studying a disease with a view to its prevention. Before the War trench fever was unknown, though there is some evidence that it had been recognised at an earlier date in Poland and called Wolhynia fever. Be that as it may, it is quite certain that, though it was unknown on the Western Front at the beginning of the War, it is no exaggeration to say that it became one of the most powerful factors in reducing our man-power, probably more than a million cases occurring among the Allies on the Western Front. In 1917 in the Second British Army alone, out of a total of 106,000 admissions to hospital at least 20,000 of the cases were trench fever.

Although this fever has well-marked characteristics of its own, such as a peculiar type of temperature curve, and other symptoms, yet for a long time it was unrecognised as a separate entity, and remained mixed up with other diseases, such as typhoid fever, malaria, and rheumatism. In 1916 MacNee, Renshaw, and Brunt in France made the first definite advance by showing that the blood of trench-fever cases was infective. They succeeded in transferring the disease to healthy men by the injection of the blood. The most careful microscopic examination of the blood corpuscles and lymph failed, however, to reveal any

living germ. Nothing more was done until the following year, when the British War Office took the matter up seriously and formed a committee for the purpose of investigating the disease.

The United States of America, on coming into the War, at once recognised the importance of trench fever, and without delay also undertook its investigation. In October 1917, at the first meeting of the Medical Research Committee of the American Red Cross in Paris, Major R. P. Strong recommended that a research into trench fever should be undertaken. He stated that, after several months' study of the problems relating to the prevention of infectious diseases occurring in the Allied Armies on the Western Front, it became evident that the subject of the method of transmission of trench fever was one of the most important for investigation in connexion with the loss of man-power in the fighting forces.

At the next meeting, in November 1917, this was agreed to, and a Trench Fever Committee, under the chairmanship of Major Strong, was formed. The research was organised, and experiments begun on February 4, 1918. In less than six months the investigation was completed and the report in the hands of the printer. This is a striking example of research work which, if carried out at the beginning of the War instead of at the end, might have saved the Allied Armies hundreds of thousands of cases of disease, which, although never fatal, were often of long duration and led to much invaliding.

The most important result of the work of these two committees was that it was amply proved that the louse, and the louse alone, was responsible for the spreading of the disease. This discovery meant that in a short time trench fever would have disappeared from our armies on the Western Front. Just as the elimination of goat's milk blotted out Malta fever, the elimination of the mosquito malaria and yellow fever, so would the elimination of the louse have completely blotted out trench fever. This method of prevention, by the destruction of the louse, although doubtless requiring careful organisation and energy in carrying out, was shown before the end of the War to be a perfectly practicable proposition, and there can be little doubt that, if the War had lasted much longer, trench fever, like tetanus, would have practically disappeared.

Besides the main discovery from the preventive point of view that the louse is the carrier, there are many other points of interest in the natural history of trench fever. The living germ causing it has never been recognised in the human blood or tissues, probably on account of its extreme minuteness, and its consequent liability to confusion with other small granules. But when the louse sucks blood from a trench-fever case there is apparently a great multiplication and development of the supposed micro-organism. In five to nine days the louse becomes infective, and there is seen in the stomach and intestines enormous numbers of very minute bodies. What the exact nature of these bodies is, is unknown, but there can be little doubt that they are the infecting agents by which the louse passes on the disease. They pass out in countless numbers in the droppings or excreta of the louse, and it is to these bodies in the excreta that infection is due. The louse seldom if ever gives rise to the disease in the act of biting. It is the infective excreta thrown out on the skin which causes the infection. The micro-organisms or so-called Rickettsia bodies contained in the excreta find their way into the blood through abrasions or scratches, and so give rise to the fever.

From what has been said it will be seen that trench fever is an interesting disease. It also explains why it disappears in times of peace. As soon as the War was ended, and our men could leave the trenches and resume their normal habits, the disease disappeared. The louse was eliminated and the trench fever with it.

Typhus Fever.

Another disease of the undetermined group closely related to trench fever and also carried by the louse is typhus fever, one more of the furies following on the heels of war. The French and British Armies escaped this scourge to a great extent, but some of the other countries, such as Serbia, Bulgaria, and Poland, were not so fortunate. It is stated that 120,000 Serbians died of this disease during the War, and it was only after vigorous steps had been taken in sanitary measures directed against the louse that the epidemic was got in hand.

After the long, exhausting Napoleonic wars, with the resulting poverty and destitution, typhus fever was prevalent in Great Britain and Ireland. About the middle of the century the improved economic conditions gradually led to the disappearance of the disease in Britain, although cases still occur in some parts of Ireland.

It is to Nicolle that we owe the advancement in our knowledge of this important disease. His work in Tunis on this subject dates from 1909. He showed that the blood of typhus cases is infective to monkeys, and, most important of all, that the infection takes place through the body louse. Just as in trench fever, the louse becomes infective after some five days, and it has been shown by the late Arthur Bacot of the Lister Institute that the excreta is also infective.

The minute bodies found in the typhus louse are, subject to some differences, very similar to those found in the trench-fever louse, and have been named *Rickettsia prowazeki* by Rocha Lima. What group these bodies belong to is still a matter of discussion. Some consider them to be protozoa, with an ultra-

microscopical stage in man and a developmental stage in the louse, while others look on them as minute forms of bacteria. Although there is still some doubt as to the pathological significance of these Rickettsia bodies, the work of Sargent, Rocha Lima, Arkwright and Bacot, Wolbach, Todd and Palfrey has done much to establish a causal relationship between them and these two diseases, typhus and trench fever.

From the point of view of prevention, the important fact is that the infection is carried by the louse, and in the next great war it will be almost as necessary to prepare means for the destruction of the lice as of the enemy.

Rocky Mountain Fever.

A third disease belonging to this interesting little group—Rocky Mountain fever—occurs in certain localities in the United States. It provides another instance of a virus transmitted by an invertebrate host to man. As the result of the work of Ricketts and of Wolbach, the wood-tick, *Dermocentor venustus*, is now recognised as the vector. Rickettsia bodies closely resembling those found in association with typhus and trench-fever virus have been shown to be present in the stomach and tissues of the tick, and the same bodies have also been demonstrated in the tissues of infected guinea-pigs.

Another interesting disease of the undetermined group is sand-fly fever, the virus of which is conveyed from man to man by the sand-fly. A new era in its study has been opened up by the work of Whittingham and Rook, who have learned how to handle, breed, and keep sand-flies in captivity, and have shown that the virus is transmitted from generation to generation of flies without intervening passage through man or other higher animal. The knowledge of the life history of the flies will no doubt lead in due course to the suppression of the disease.

Another type of invertebrate vector is the Kedani mite, *Trombicula akamushi*, which transmits the virus of Japanese river-fever to man from wild animals. The dangerous character of this disease (Tsutsugamushi) and the minute size of the mite together have presented great difficulties to the Japanese investigators. Protection from the mite by special clothing and bathing after exposure to risk of infection are at present the most hopeful methods of prophylaxis.

Antitoxic sera have also been used with some measure of success in the prevention of diseases of this group. Degkwitz and others in Germany are reported to have been very successful in protecting children from measles and scarlet fever by injecting them with a small quantity of serum from convalescent patients. This method has also been found very useful under suitable conditions to protect cattle from foot-and-mouth disease.

But far more hopeful than protection by serum alone is the use of a vaccine to produce a lasting immunity, combined with antitoxin to prevent the vaccine from producing unpleasant results—the so-called toxin-antitoxin method. Most of the diseases for which this method of prophylaxis has proved valuable have been diseases of animals, such as pleuro-pneumonia of cattle, rinderpest, and foot-and-mouth disease; but quite recently the method of Dick, of Chicago, in scarlet fever has been supported by a number of observations. The system of testing and producing immunity is planned on the same lines as the Schick method for diphtheria.

Dietetic Deficiencies—Deficiency Diseases.

The preceding account is but a short and meagre history of the marvellous advance which has been made in the prevention of infectious diseases in our times, an advance due in great part to the work of two men, Pasteur the Frenchman and Koch the German; those who have come after them have merely followed in their footsteps, been their disciples.

Time will not permit even to touch upon the advances made in the prevention of other important diseases, such as the surgical infections and those caused by intestinal parasites, prominent among which are the hookworms and bilharzia. This advance has not been limited to the infectious group: it has been shared by other groups, notably those due to dietetic deficiencies, the so-called deficiency diseases. These deficiency diseases are just as important, or even more important, than the infectious, since they are always with us and exact an enormous toll in lowered health, lowered vitality, malformation, and inefficiency.

Until a few years ago it was taught in the schools that a complete diet consisted of certain proportions of proteins, carbohydrates, fats, and salts. But our knowledge is constantly increasing, our ideas about things constantly changing, and what is looked on to-day as absolute immutable truth to-morrow is seen in the light of some newer knowledge to be but a crude beginning. So the teaching concerning what constitutes a complete and healthy diet has changed, inasmuch as certain substances have been discovered in food-stuffs in the absence of which an adequate number of calories supplied in the form of proteins, carbohydrates, fats, and salts can alone neither promote growth nor support life indefinitely. These accessory food factors, or vitamins as they have been named, are present in such minute quantities in foods that they have never been isolated, and their chemical composition is therefore unknown. It is still a matter of opinion as to whether they really constitute parts of the structure of living tissues, or whether they merely act as catalysts or stimulators in the process of growth and metabolism. That they are definite chemical

substances which can be added to or removed from a food-stuff, with good or evil results, has, however, been abundantly proved.

The untutored savage living on the natural fruits of the earth and the chase knows no deficiency diseases. It is only when man begins by artificial means to polish his rice, whiten his flour, and tin his beef and vegetables that the trouble begins. Civilised man living in comfort, drawing his food supply from the whole earth and able to vary his dietary at will, is in little danger; but it is otherwise with children and adults living under institutional conditions, with armies on active service, encountering extremes of climate, and with young infants on their naturally restricted diet. While it is true that deficiency diseases will only develop to their well-marked dangerous stage if the deficiency of accessory factor is severe and protracted, a slighter deficiency, if prolonged, may cause a condition of general ill-health and inefficiency not less important although ill defined and difficult to diagnose. This fact is of special importance in the case of infants and young children.

The Discovery of Vitamins.

At the present time, three, and possibly four, distinct vitamins have been described and studied, and it is probably only a matter of time for others to be discovered.

The discovery of vitamins dates to the middle of the eighteenth century. In 1747, James Lind, a surgeon in the British Navy, carried out a series of experimental observations upon sailors suffering from scurvy, the conception and performance of which were entirely admirable. By appropriate control experiments he showed that the medical means in vogue for the treatment of the disease were futile, when not harmful, but that orange and lemon juices were a specific cure. Lind attempted to ascertain the relative anti-scorbutic value of various fruits and green vegetables, but was unable to observe a "superior virtue" in one rather than in another. He confirmed Kramer's observations made at the beginning of the eighteenth century, during the war between the Turks and the Holy Roman Empire, that dried vegetables were useless, and adopts the explanation of his friend Cockburn "that no moisture whatever could restore the natural juices of the plant lost by evaporation," which Cockburn imagined were "altered by a fermentation which they underwent in drying."

Lind was struck with the beneficial effect of cow's milk in the treatment of scurvy. He explained it on the supposition of the milk "being a truly vegetable liquor, an emulsion prepared of the most succulent wholesome herbs." Lind applied himself to the applications of these discoveries for the prevention of scurvy in the Navy, and recommended lemon-juice concentrated to a syrup by evaporation to be carried in all ships and served out to the sailors. By the beginning of the nineteenth century the carriage of lemon-juice was made compulsory, first in the Navy and subsequently in the mercantile marine, with the result that the ravages of scurvy were prevented. With the advent of steam traction, too, the length of voyages was curtailed and supplies of fresh provisions were obtained at more frequent intervals. Scurvy became rare, and the medical profession, being no longer faced with this disease of dietary deficiency, soon forgot the significance of Lind's discoveries.

Before leaving this subject a curious fact may be related. The lemon-juice supplied to the Navy was at first made from lemons grown in Spain and the Mediterranean countries. Afterwards, when England took over the West Indies, it was made from the lime, and scurvy again broke out. The reason of this is now known to be that, whereas the lemon is particularly rich in anti-scorbutic vitamin, the lime is correspondingly poor.

The scientific study of the disease may be said to have lapsed for a century and a half, until Holst and his co-workers in Copenhagen investigated the etiology of scurvy anew on modern lines, with the help of experiments on animals. Their work, published in 1907 and 1912, formed the basis for the numerous researches carried out in England and America during and since the recent War. As a result of this work the etiology of scurvy, discovered in effect centuries earlier, has been firmly established as due to lack of a specific, undetermined, and as yet unisolated, constituent of fresh foods, especially of fresh vegetables and fruits, now known as Vitamin C.

In the meantime the existence of a second vitamin, the so-called anti-beri-beri, or anti-neuritic vitamin, Vitamin B, had been discovered. Eijkman's admirable studies at the end of last century, in 1897, on the etiology of beri-beri in the Dutch Indies, brought forward evidence for the view that this disease was of dietetic origin, and was caused by a diet consisting too exclusively of highly milled and polished rice. He showed that the disease could be prevented if the outer layer (or pericarp) and the embryo of the seed, which had been removed in the process of milling, were restored to the "polished" rice. Eijkman's discovery of the analogous disease in birds, *Polyneuritis gallinarum*, provided the necessary tool for further investigation of the subject. The researches of Grijns and others showed that the bran and polishings of rice were only one of many rich natural sources of the unknown principle preventing beri-beri, and it became evident that, while the disease is usually confined to tropical races subsisting largely on rice, the European white-bread eater is protected only by the varied diet he usually enjoys. Experience on active service shows that beri-beri may really develop on a diet of tinned meat and white bread or biscuit.

During the late War two examples of the use made of this new knowledge occurred in Mesopotamia. At the beginning of the campaign, on account of a difficulty in transport, there was a shortage of fresh food, with the curious result that scurvy broke out among the Indian troops and beri-beri among the British. The Indians were living on dried pulses, such as peas, beans, and lentils; the British on tinned beef and biscuits. The former diet was deficient in the anti-scorbutic vitamin on account of the complete drying of the seeds; the latter in the anti-beri-beri factor on account of the use of white flour from which the germ had been removed.

Some years ago it had been discovered that if dried seeds are germinated, a quantity of the anti-scorbutic vitamin is produced by the act of sprouting. This was done. The dried peas and beans were soaked in water and then spread out in shallow layers, to cause them to sprout, which they readily did in the warm climate. The germinated seeds were then issued to the Indian troops and cooked in the usual way. As a result of this simple procedure the scurvy completely disappeared.

In regard to the British troops it was known that the anti-beri-beri vitamin is contained in large quantities in certain cells, and notably in yeast cells. A small quantity of this substance in the form of marmite was added to the soldier's diet of bully-beef and biscuits, and the beri-beri in like manner disappeared.

It may seem strange that the conception of the rôle of vitamins in nutrition should have come first from the pathologist, and should not have emerged from the important advances in our knowledge of the physiology of nutrition which were made during the second half of the last century. The physiologists were preoccupied with the chemical composition of food-stuffs and their value for supplying energy and supporting growth, and with the necessity for supplying the requisite number of calories in a diet, distributed appropriately among proteins, fats, and carbohydrates, with adequate selection of mineral salts. It was only when these researches led to experiments in which animals were fed upon various mixtures of purified food elements that the investigators in this field began to realise that their repeated failures to rear animals upon such carefully arranged diets were not due to accident. The truth was suspected by Lunin in 1881, but it was not until 1912 that Hopkins published the classic experiments which proved the fact beyond a doubt. In the course of work along the same lines in the United States, McCollum and Davis in 1915 rediscovered Vitamin B, and, in addition, a third essential dietary constituent, a fat-soluble vitamin, present in butter-fat and certain other fats of animal origin, especially in cod-liver oil and other fish oils. This vitamin is known as fat-soluble Vitamin A.

Rickets as a Deficiency Disease.

The discovery of the fat-soluble vitamins proved to be of great importance in elucidating the etiology of this disease, which had for long been an unsolved problem. Some authorities had erroneously considered it to be an infectious disease, like tuberculosis. Another school held the so-called Domestication Theory, that it was caused by unnatural surroundings, involving a want of sunlight, fresh air, and exercise. A third considered rickets to be caused by improper feeding, though opinions differed as to the exact nature of the dietetic defect. The conclusion, first put forward by Mellanby in 1918, that a deficiency of fat-soluble vitamins plays a most important part in the causation of the disease is now generally accepted. This has been established by a large amount of work, both experimental and clinical, carried out by Mellanby himself, McCollum and Hess and their respective co-workers in the United States, and Korenchevsky and others in England. It may be laid down that if a young animal is supplied with a sufficiency of these vitamins, rickets will not develop. The question of prevention is therefore one of economics. The difficulty is that these fat-soluble vitamins are chiefly found in such food-stuffs as butter, eggs, the fat of beef and mutton, and fish oils, all expensive articles of diet which the poorer classes can seldom afford. The only "butter" used by them is probably some form of margarine, made from vegetable oils which contain little or no anti-rachitic vitamin. The question of prevention is for the sociologist. Science can only discover the causes and point the means. It is for governments and local authorities to carry out preventive measures in practice, and it is to be feared that science is often far ahead of the community in its share of the work.

Although the theory that rickets is an infectious disease has been exploded, a great and remarkable truth was contained in the domestication and hygienic theories which held that, among other unhygienic conditions, want of sunlight was concerned in the etiology of the disease. During the last five years it has been discovered that exposure to sunlight or to the ultra-violet rays of the mercury vapour quartz lamp can cure rickets in children. Experiments on animals have shown that the effective rays in the sunlight are also the ultra-violet. This discovery has indicated lack of sunlight during winter as one factor concerned in the large spring incidence of the disease in industrial cities in northern climates.

A complete and well-controlled research showing the interaction of diet and light in the prevention and cure of rickets in infants was gained in Vienna, since the War, by Dr. Harriette Chick of the Lister Institute and her four colleagues. There the curious fact came to light that infants fed on a diet deficient in anti-rachitic vitamin developed the disease only in winter and not in summer, and, moreover, could be cured in winter by exposure to artificial forms of radiation or by administration of cod-liver oil without any other change in diet or management. Another set of children who had a sufficient supply of fat-soluble vitamins in their diet, in the form of cod-liver oil, escaped the disease altogether.

Experiments on rats have also shown that in animals fed on a rickets-producing diet, rickets does not occur if the rats are exposed regularly to sunlight or to the rays of the mercury lamp, or other form of artificial ultra-violet radiation; whereas, if they are kept in the dark, rickets does develop. If, on the other hand, the diet is complete in all respects, including abundance of fat-soluble vitamins, the animals do not develop the disease, even if kept constantly in the dark.

How this is brought about is not known. At one time it was thought that the action of the ultra-violet rays on the tissues might enable the animal to syn-

thesise fat-soluble vitamins, as it does in the tissues of plants, but recent evidence brought forward by Miss Margaret Hume in Vienna, and by Goldblatt and Soames at the Lister Institute, suggests that light can neither create nor act as a substitute for the vitamin. It seems rather to act as a stimulant, enabling the animal to make full and economical use of its store of fat-soluble vitamins, and when the store is used up growth ceases in spite of the continued action of the rays.

An important and practical point in regard to the connexion between diet and sunlight and the formation of the anti-rachitic vitamin is the relation to cow's milk. Recent work carried out by Dr. Ethel Luce at the Lister Institute has shown that milk obtained from a cow on pasture in summer contains a sufficiency of the growth-promoting and anti-rachitic fat-soluble vitamins. In winter, on the other hand, if the cow is stall-fed and kept in a dark stable, the milk may become deficient in these respects and young animals fed on it may become rachitic. This work shows that the seasonal variation in quality of the cow's milk may be an additional factor in the seasonal incidence of infants reared upon it. It also disposes of the idea, very current in some quarters, that cow's milk possesses low and negligible anti-rachitic properties and that the anti-rachitic properties of cod-liver oil are specific and peculiar to that substance.

Enough has been said to show that rickets may be regarded as a disease of sunless houses combined with a diet deficient in the anti-rachitic vitamin, and the means of prevention are sufficiently obvious, if not always easy and simple to carry out. Doubtless in the future this new knowledge in regard to the accessory food factors in diet will be used to a greater extent than it has been up to the present, in which case it is not too much to expect that the city children of some future generation will have better-grown bodies and stronger, healthier teeth than their predecessors of the pre-vitamin age. This might be attained in a comparatively near future if only man could be allowed to work out his salvation in peace. Instead of this, great wars come and throw back the work for generations.

To saddle the country with a million and a half of unemployed, with the consequent poverty, insufficient food, clothing and housing, is not calculated to further the prevention of disease and raise the standard of health. Is it too much to hope that in the revolving years a time may come when by a Confederation or League of Nations the world may be so policed that no one country will be able with impunity to attempt the destruction of its neighbour? Until this happens it is difficult to see how rickets, tuberculosis, and other diseases can be adequately dealt with in our city populations.

Diseases due to Ductless Glands

I can only briefly allude to the astonishing advance in our knowledge of the diseases caused by a defect or excess of secretion of the ductless glands. Many of these discoveries are among the fairy tales of science. All this advance has taken place in the comparatively short space of time under review.

Prof. Starling, one of the chief protagonists in this advance, in his Harveian Oration a year ago states this very vividly: "When I compare our present knowledge of the workings of the body, and our powers of interfering with and of controlling those workings for the benefit of humanity, with the ignorance and despairing impotence of my student days, I feel that I have had the good fortune to see the sun rise on a darkened world, and that the life of my contemporaries has coincided not with a renaissance but with a new birth of man's powers over his environment and his destinies, unparalleled in the whole history of mankind. Not but there is still much to be learned: the ocean of the unknown still stretches far and wide in front of us, but for its exploration we have the light of day to guide us; we know the directions in which we would sail, and every day, by the co-operation of all branches of science, our means of conveyance are becoming more swift and sure. Only labour is required to extend almost without limit our understanding of the human body and our control of its fate."

There is one point of likeness between the vitamins which we have been considering and these glandular secretions, or hormones, as they are named. Just as we have seen that the presence or absence of an extremely minute quantity of a vitamin may determine growth and health or disease and death, so an extremely minute quantity of glandular secretion may have a similar effect.

The anterior lobe of the pituitary gland is a very small body, yet an excess of its secretion will cause a child to grow into a giant; a deficiency, and the growing child will remain an infant.

The best known of the ductless glands is the thyroid, and the effect of its secretion is truly marvellous. A deficiency, and the child grows up a heavy-featured, gibbering idiot. Rectify the supply of thyroid secretion; the heavy features disappear, the eyes brighten, the intelligence returns, and instead of the former heavy-jowled imbecile you have a bright, happy, and normal schoolboy. On the other hand, if there is an excess of the thyroid hormone, exophthalmic goitre, or Graves's disease, is the result. Remove the redundancy and health returns.

The active principle of the thyroid has lately been shown to be a compound containing iodine. If there is no iodine in the soil or water, goitre is the result, as in parts of Switzerland, Canada, and the United States. This aspect of the subject was taken up some ten years ago by Dr. David Marine and his colleagues at Cleveland, Ohio. They find that endemic goitre may be prevented by the simple method of giving for a time minute doses of iodine, and conclude that with this simple, rational, and cheap means of prevention, this human scourge, which has taken its toll in misery, suffering, and death throughout all ages, can and should be controlled, if not eliminated, and look forward in imagination, a few generations hence, to the final closing of the chapter on endemic goitre and cretinism in every civilised nation in the world.

Many advances have also been made in our knowledge of the function and uses of other ductless glands, and, as you know, the latest victory in this field is the discovery of insulin and the successful treatment of severe diabetes, for which magnificent work your own townsmen Banting and Best deserve the highest honour.

In many other directions than those touched upon has there been progress in the prevention of disease.

It would take more than one address to describe the activities of the Rockefeller Foundation alone. Campaigns for the relief and control of hookworm disease, malaria control, the eradication of yellow fever, anti-tuberculosis work and education are being pursued on such a scale and at such a lavish expenditure of money as to leave us in the Old Country breathless with admiration and envy.

This Foundation, incorporated in 1913, was founded, in the words of the president, " to stimulate world-wide research, to aid the diffusion of knowledge, to encourage co-operation in medical education and public health." Its chartered purpose is to promote, not the exclusive prosperity of any one nation, but " the well-being of mankind throughout the world."

Science, indeed, knows no boundaries of nations, languages, or creeds. It is truly international. We are all children of one Father. The advance of knowledge in the causation and prevention of disease is not for the benefit of any one country, but for all—for the lonely African native, deserted by his tribe, dying of sleeping sickness in the jungle, or the Indian or Chinese coolie dying miserably of beri-beri, just as much as for the citizens of our own towns.

From what has been said, it is abundantly clear that during the comparatively few years that have passed since this Association first met in Canada, enormous advances have been made in the prevention of disease. Before that time we were still in the gloom and shadow of the Dark Ages. Now we have come out into the light. Man has come into his heritage and seems now to possess some particle of the universal creative force in virtue of which he can wrest from Nature the secrets so jealously guarded by her and bend them to his own desire.

But let there be no mistake; much has been done but much more remains to be done. Mankind is still groaning and travailing under a grievous burden and weight of pain, sickness, and disease. Interruptions are sure to come in the future as they have in the past in the work of removing the incubus, but, in spite of these, it is the duty of science to go steadily forward, illuminating the dark places in hope of happier times.

Scientific Problems and Progress.

ABSTRACTS OF ADDRESSES OF PRESIDENTS OF SECTIONS OF THE BRITISH ASSOCIATION.

CHEMISTRY AND THE STATE.

IN Section B (Chemistry) Sir Robert Robertson took " Chemistry and the State " as the subject of his presidential address. The relations of the State to chemistry in Britain originated in the necessity for self-protection; they developed from motives of expediency; and they have culminated in direct Government aid for research. From the time when gunpowder was first made for the State in the fourteenth century down to the production of amatol during the late War, the State has always interested itself in the manufacture of explosives, but important scientific research in this connexion began under Abel and his co-workers, Kellner, Deering, Dewar, and Dupré, who developed the use of guncotton and cordite. Outstanding advances in the manufacture of explosives emanated from the Royal Gunpowder Factory, and general research was carried out both there and in the Research Department, Woolwich. The War caused an enormous expansion of the State's activities in the production and investigation of chemical means of defence and offence.

The relations of the State to metallurgy were mostly sporadic before 1914, the main advances arising from private effort, but Percy, Abel, and Roberts-Austen, all of whom held official posts, assisted the Government in many inquiries, and more recently notable work on the non-ferrous alloys has been done at the National Physical Laboratory, ferrous metallurgy being studied in the Research Department, Woolwich. The State has always maintained a close connexion with minting, and many of the Mint officials, including Hofmann, Graham, Miller, Stenhouse, and Roberts-Austen, have made important additions to metallurgical science.

Expediency caused the State to levy duties on alcoholic liquors, tobacco, and other commodities. Richard I. imposed a duty on imported wine, and under Charles II. acts were passed to prevent the mixing and adulteration of wines (it is still illegal to mix wines of different kinds). Accurate methods of testing spirits, etc., have been elaborated in the Government Laboratory, and much work has been done there on the denaturing of alcohol.

Playfair, supported by the Prince Consort, pioneered the direct intervention of the State in sanitation and control of the quality of foodstuffs; investigations on the adulteration of foods and drugs followed and led to the appointment of public analysts, to the extension of the work of the Government Laboratory, to the establishment of the Ministry of Health, and to the formulation of certain definitions and standards for spirits, dairy products, preserving and colouring matters in foods, etc. The State has also promoted or done very valuable work on the purity of water supplies, the disposal of sewage, the contamination of the atmosphere, and has established chemical control of many manufactures dangerous to health.

Although Humphry Davy was a member of the first Board of Agriculture, formed in 1793, progress in agricultural chemistry was left to private enterprise for more than a century; the establishment of the Development Commission in 1909 paved the way to important advances which have originated at Rothamsted and other State-supported institutions. The shortage of fixed nitrogen and of potash during the War made Government action imperative; and the valuable work of the Nitrogen Products Committee has been followed up by the establishment of a nitrogen industry at Billingham-on-Tees, where 150 tons of synthetic ammonia are now being produced daily.

The greatest advances in chemistry have been made in the universities and by private workers, but the contributions from Government institutions have not been unimportant; and the benefit has been mutual. During the War the State recognised its obligation to

foster research, both in pure and applied science. Under the schemes of the Department of Scientific and Industrial Research the smaller chemical manufacturers are co-operating in the investigation of common problems, and the assistance extended by that department to academic workers shows that the State recognises the truth of the dictum that "research in applied science may lead to reforms, but research in pure science leads to revolutions."

Geology in the Service of Man.

Prof. W. W. Watts, president of Section C (Geology), selected "Geology in the Service of Man" as the subject of his presidential address. He pointed out that the mining industry, by providing exposures of rocks in mines, and by demanding as it did accurate knowledge of the nature and structure of the earth's crust, had been an important factor in the growth of the science of geology. He paid a tribute to the early work of Werner and William Smith from this point of view. It is a curious fact that these two pioneers of the science of geology were strongly imbued with a sense of the utility of geological science, and made their contributions to the establishment of the science with an economic motive. During the nineteenth century the purist attitude of mind became dominant among geologists, and it can scarcely be said to have faded out as yet; but, as Prof. Watts remarked, the feeling of mutual suspicion and distrust between the purely scientific and economic workers is fortunately passing away. The scientific and economic workers now find that they are mutually indispensable, and are everywhere co-operating in the work of developing and exploiting the mineral wealth of the earth's crust.

With reference to the study of geology as a factor in educational training, Prof. Watts deplored "the tendency in early education to squeeze out other sciences in favour of those that are called fundamental, and to suppose that, because it makes use of most other sciences, training in geology ought not to be begun until the other sciences have been mastered." He pointed out that, in consequence of this tendency, the habit of close observation is not being cultivated as it should be. The student's early propensity for making observations is blunted unless it be encouraged by studies such as those of practical geology, the pursuit of which has the additional advantage that it gives the student a stronger incentive to the study of the fundamental sciences and shows him their utility.

Under the sub-headings coal, oil, metals etc., stone etc., roads, water, power, agriculture and forestry, military science, geography, and biology, Prof. Watts showed in an interesting way how very wide, permeating, and altogether important are the influences of the science of geology in the service of man. The address will be read with much interest by all who appreciate the economic value of science in general and geology in particular.

Racial Problems and Colonisation.

As president of Section E (Geography), Prof. J. W. Gregory, in his address on "Inter-Racial Problems and White Colonisation in the Tropics," appropriately directed attention to the immense problems of population arising from the unification of the modern world by the movements and organisation of commerce. Peoples of very diverse heredity are brought into mass contact, and the results are difficult to evaluate, especially as prejudices of many and often conflicting types enter into the discussion. Prof. Gregory quotes views on many points, and scarcely attempts to give an opinion on racial fusions; he indicates South America as a region where such fusion has occurred and is still developing on a large scale, and the United States of America as a region where the strongest opposition to such fusion has been offered by both sides. He evidently thinks that the maintenance of black and white side by side but distinct in the U.S.A. is an impossibility, especially in view of the increase of southern European elements in the population of late years. In that opinion he wins the agreement of a great many thinkers and workers. Prof. Gregory, however, scarcely gives attention to modern demographic work in the U.S.A., such as that of W. F. Willcox, who claims that in every one of the Northern States negro deaths exceed negro births, and that this is probably true in cities generally. Moreover the negro, as Prof. Gregory shows, is tending to move to the towns. Willcox and his fellow-workers do not expect the negro to maintain himself at 19 per cent. of the population, but argue that in the year 2000 he may be only 5 per cent. This, however, may presuppose a rather large increase of whites, and may not take enough account of the influence of southern Europeans in producing "near-whites." At any rate it seems clear that census errors in 1870 have spread an erroneous idea about increase of negro population in U.S.A.

Prof. Gregory touches the South African problem, where the "black" is at home and increasing, while the white finds more difficulty in maintaining himself physically and economically than he seems to indicate. He seems right in urging that the Nationalist Labour Coalition in South Africa is based on racial politics, with the ideal of black segregation, in the hope that large areas may become homes of pure Europeans. The hope is dim enough Prof. Gregory is enthusiastic about the white Australia policy, and upholds strenuously the view that disease, not climate, is the enemy of white settlement in the tropics. From this point of view he makes the most of the partial success of North Queensland, and discounts failures in the Northern Territory as due largely to lack of organisation, railways, etc. At the same time he acknowledges that, where wet-bulb temperatures are high, the environment is against strenuous mental activity, though he does not go so far as does Dr. Leonard Hill towards suggesting that the white man would need to modify himself and his ways in order to occupy Northern Australia seriously. Nor does Prof. Gregory mention the probability that what may drift to Northern Australia may be a Pass-for-White population. He rightly points out that there are immense spaces that the surplus population of China may occupy in Asia, but he does not seriously refer to the delicate and pressing problem of the crowded population of Japan. It is doubtful whether many Japanese constitutions could stand interior continental climates in Asia at all. One cannot but welcome an

interesting statement of a position taken up by a much-travelled geographer on the most urgent problem of our time.

Free Trade Doctrine.

Sir William Ashley took as the subject of his presidential address to Section F (Economic Science and Statistics) " A Retrospect of Free Trade Doctrine." There is a peculiar appropriateness in both speaker and subject. Sir William Ashley went to Toronto in 1888 to occupy the first chair of political economy in Canada; he has been throughout his career the chief academic critic of free trade in the English-speaking world. His address has, however, only an incidental bearing on current controversies. The doctrine that he expounds and criticises is the doctrine formulated by Adam Smith and his successors, in the century that began with the publication of " The Wealth of Nations " and ended with the new orientation given to economic studies by Jevons and Cliffe Leslie.

Sir William Ashley begins by formulating the doctrine for convenience of reference in nine propositions. Each of these he then expounds with an abundance of quotations from representative economists of the period, and proceeds to criticise in the light of economic developments during the period and since its close. In the main the address is an essay in the history of economic thought, marked by the literary grace and the pleasantly acid wit that characterise Sir William Ashley's critical work; so far as it has an object beyond this, it establishes the conclusion that the political doctrine of Smith and Cobden and Mill belongs to the thought and conditions of an age that is past.

It is the doctrine, not the policy, of free trade with which the address is concerned, and this the president shows conclusively is based, not on an inductive argument from experience, but on the optimistic philosophy (or theology) of Nature that was common to " The Theory of Moral Sentiments " and " The Wealth of Nations." The identities of phrase in the two are cleverly used to bring out the a priori character of the latter. Nature is beneficent; it follows that the unrestricted freedom of the individual to pursue his own interest can have only beneficent effects. Such freedom is a " natural " right; State interference is " artificial." It follows that the individual interest and the social interest are identical, and society is nothing more than a collection of individuals. A subsequent age, with a different philosophy, has had no difficulty in seeing that the use of " Nature " and " natural " in these connexions is question-begging. The purely economic elements in the doctrine show more definitely the influence of contemporary economic conditions; the criticism to which they are subjected is also different. They are tested by reference to economic facts and conditions of their own and other times, and their inadequacy brought out. Social policies have changed as much as social philosophies.

The free trade doctrine was the creation of philosophers and the instrument of practical men. This summary of its content and development brings out the changes that economics had to make in its objects and methods before it could claim to be scientific. The address is typical of the work which Sir William Ashley has done to free the study from the bonds of mere analytical introspection.

Engineering Position and Prospects.

Prof. G. W. Howe, in his presidential address to the Engineering Section, gave a *résumé* of the advances made in engineering during the last hundred years. He regarded Faraday's discovery of the principle of the electro-motor in 1821 as the birth of electrical engineering. It was not, however, until ten years later that Faraday discovered magneto-electric induction. The early workers did not realise that a dynamo could be used either as a generator of electrical energy or as a motor. Lord Kelvin installed one of the earliest house-lighting installations at 11, The University, Glasgow, in 1881, using a gas engine to drive a Siemens dynamo. The pressure was 85 volts and Swan lamps were used, but Kelvin had to design his own switches and fuses and think out how to support and distribute his lamps.

Prof. Howe mentions that in Glasgow he pays 5*l.* per ton for anthracite to burn in a slow-combustion stove. Assuming that the calorific value of anthracite is 14,000 B.T.U. per lb., this works out at 7·5 kilowatt-hours for a penny. He pays a penny for a kilowatt-hour for heating and cooking. For continuous operation, therefore, the high efficiency and convenience of a slow-combustion stove makes it much the more desirable. When, however, intermittent heating is desired the electric radiator may be the more economical. An interesting account is given of how the output attainable from a given size of machine has been slowly but continuously increased. This is due to the improvements in the electrical, magnetic, and mechanical properties of the materials used as well as to improvements in design. Considering the modern direct current motor, the freedom from trouble of the enormous number of motors in electric trams and trains is a testimony to their trustworthiness.

Prior to 1890 Ferranti had built the Deptford Power Station and was installing large 10,000 volt alternators to supply London with electric light. In 1913 the largest turbo-alternators had an output of 7500 kilowatts. Now, machines of 30,000 kw. and even 60,000 kw. are in operation. Electric traction has absolutely revolutionised the methods of transport within a single generation. Although 500-volt direct current supply has been standardised for tramways, the relative merits of direct current and alternating current for traction purposes are still being discussed. Prof. Howe is inclined to regard three phase supply for traction, notwithstanding its successful application in Northern Italy, as being antiquated. The battle is now confined to direct current at pressures between 1500 and 2000 volts and single phase alternating current. In the latter case the question of the most desirable frequency is not yet settled. The development of the alternating current traction motor during the early years of this century has made possible so many simplifications and economies in transmission that it is yet a moot point whether A.C. or D.C. is best for main line electrification.

Within the last thirty years the provision of an

abundant supply of electric power has led to the creation of enormous electro-chemical industries. The production of aluminium, carborundum and calcium carbide by electrical energy obtained from waterfalls may be specially mentioned. In 1926 the jubilee of the invention of the telephone by Alexander Graham Bell will be celebrated. The great advances recently made in automatic telephone stations where the operator is entirely eliminated and the subscriber himself makes the required connexion are well described as marvellous. What were considered wild dreams, twenty years ago, of the future of radio-communication have been completely realised in everyday practice. The commonplace radio-broadcasting of to-day appeared outside the bounds of possibility a few years ago. Thirty years ago a ship at sea was completely isolated from the life and thought of the world. It is now in continuous communication with the land and with every ship within a range of many miles. Prof. Howe points out that in no branch of electrical engineering is there any question of finality being attained. Rapid development is taking place in every direction, and new natural sources of energy are continually being utilised for the benefit of humanity.

National Health and Physique.

In his presidential address to the Section of Anthropology, on "Health and Physique through the Centuries," Dr. F. C. Shrubsall reviews some of the evidence relating to improvement or deterioration in national physique from early times, and more especially under industrial conditions. Referring to the recent recruiting experience in Britain, he rightly points out that the National Service Survey of 1917–18 covered a population from which the best physical material had already been taken, and the marked inferiority in the average stature deduced from these returns as compared with that of recruits of British parentage drafted from the United States may be partly due to this fact, but also no doubt to the tendency of the best physical types to emigrate. School medical and recruiting data agree in showing the inferiority of the industrial as compared with the rural populations both in stature and general physique, but we are told that there is little or no evidence of deterioration of any one racial type in either respect since the beginning of the industrial era, but rather the reverse. The great increase in the expectation of life at the younger ages, which has undoubtedly occurred since Roman times, has been accelerated in the last two decades, as shown by the most recent life tables. The falling death-rate and improved health of the towns must be largely due to gradual removal of adverse conditions of labour, housing, and sanitation, which probably reached their worst level early in the last century, with the consequent stamping out of certain epidemic diseases and reduction in infant and adult mortality.

To proceed from this, however, to draw the conclusion that we are therefore physically and mentally a fitter race is only, it may be urged, to create a false sense of security. The evidence that there has been an advance in physical and mental characters at all comparable with the improvement in environment, if at all, is most inconclusive, though it cannot be doubted that such changes are making the race happier. The tendency of public health measures to aid the survival of inferior stocks may on the contrary have the reverse effect, and the declining fertility and marriage rate of the classes with the best physique in recent years is a matter of serious import for the future. Such eugenic considerations, which are of primary importance in the determination of national physique, are scarcely given their full weight in the address, and its optimistic tone will not appear to all students of racial problems to be justified by the facts.

The closing plea for an extension of anthropometric investigations in Britain, using the term in its wider sense, is, however, well worthy of consideration, for, to quote from the address, "it is only on the basis of careful physical and mental surveys that legislation directed towards social and racial hygiene could properly be introduced and rightly justified." When the Board of Education refuses to countenance the loss of half a day's education for the purpose of an anthropometric research on modern lines on the adolescent boys of a London school, one can only conclude that Britain has not yet awakened to the fact that the lack of such information in this country is a deplorable handicap to the intelligent discussion of such questions.

Specific Treatment of Infections by Artificial Remedies.

For his presidential address before Section I (Physiology), Dr. H. H. Dale chose for his subject "Progress and Prospects in Chemotherapy," which he defined as the specific treatment of infections by artificial remedies. He showed how recent investigations have attempted to solve the difficult problem of the method of action of specific remedies. The view that a drug acts as a direct poison to the parasite is quite insufficient, as also is Ehrlich's doctrine that in order to be specific a drug must have a maximal affinity for the parasite and a minimal one for the tissues of the host. It is becoming increasingly evident that drugs act favourably not only as a result of any action they may have on the parasite, but by virtue of the response of the tissues of the host. Ehrlich and Shiga showed that Trypan red would cure a mouse infected with *Trypanosoma equinum*, but that it failed in the case of the guinea-pig, rat and dog infected with the same trypanosome. Similarly Bayer "205" rids mice of trypanosome infections but is much less active in the same trypanosomes in the ox and horse.

It is evident that the host factor plays an important part in the curative process. Ehrlich found during his experiments with atoxyl that strains of trypanosome became resistant to the drug, and that this was maintained though the virus was passed through a long series of mice. Mesnil and Brimont, however, showed that if the virus was passed into the rat it was no longer resistant, though when again inoculated into mice the resistance became at once apparent. It would seem that the trypanosomes in the mice had become tolerant, not of atoxyl itself but of some product resulting from the action of atoxyl on the tissues of the mouse, though still remaining susceptible to a similar substance derived from the action of the drug on the tissues of the rat.

Neither Trypan blue nor Bayer "205"—and this is true of many other specific remedies—has any visible toxicity for trypanosomes when applied to them *in vitro*, though some physiological change is brought about as demonstrated by a loss of virulence. Salvarsan has no lethal action on spirochætes or trypanosomes *in vitro*, but after reduction to the corresponding arsenoxide it is intensely toxic to them. Voegtlin and his co-workers have produced evidence that such a reduction or oxidation resulting from contact of the drug with the tissues of the host accounts for its remarkable action in spirochæte and trypanosome infections. Levaditi demonstrated that atoxyl became lethal to trypanosomes *in vitro* after it had been incubated with an emulsion of liver, and he supposed that the actual curative agent was a substance "trypanotoxyl" resulting from a combination of atoxyl with some constituent of the liver or other tissue Similarly, the therapeutic action of bismuth salts was attributed by Levaditi and Nicolau to a similarly produced "bismoxyl." Voegtlin has shown that the toxic action of the organic arsenoxides on trypanosomes and host tissues is depressed if various sulphydrile compounds are injected simultaneously with the drug, and as a result of the work of Hopkins he has suggested that the resistant strains referred to above may be due to the trypanosomes having acquired a capacity for producing such sulphydrile compounds in excess of their vital needs.

Another illustration of the participation of the tissues of the host is seen in the case of emetin in amœbic dysentery. The alkaloid has no action on the amœbæ *in vitro*, but is endowed with remarkable therapeutic properties when administered to human beings suffering from this infection. It appears to have little or no action on the same infection in cats. Whether the drug so affects the human tissues that they are no longer capable of affording nourishment to the amœbæ, or whether the amœbæ themselves are weakened so that they fall victims to the natural protective power of the host are problems which still await solution. Morgenroth has expressed the opinion that quinine acts in malaria by combining with the red blood corpuscles and so rendering them unsuitable for invasion by the young parasites.

The tissues of the host may influence the action of a drug in another way. They may fix the drug so that its rapid excretion is prevented and by a gradual liberation of small quantities of the drug itself, or of some substance they have elaborated from it, prolong the action on the parasite. Morgenroth has shown that "Rivanol" is fixed by the red blood corpuscles or subcutaneous tissues and in inflammatory conditions due to streptococci it is gradually given up and retards the development of the cocci. Similarly Bayer "205" is held up in the body for long periods, for animals which have received a dose of the drug are protected against infection, while the serum of such an animal may actually bring about a cure in one already infected. It has been shown that Bayer "205" enters into combination with certain constituents of the blood which is thereby altered in character.

It is along lines such as these that chemotherapeutic investigations are being conducted, and though in many cases it has appeared that specific remedies have been discovered empirically, during recent years advances have been made which go far towards affording a rational explanation of the various mechanisms involved in their action and which, in the future, will yield results of importance from the point of view of practical therapeutics.

Purposive Striving as a Fundamental Category of Psychology.

Psychology is something of a newcomer among the sciences, so that it is not surprising that there should be doubt about its standing among its older sisters. Psychologists are not quite sure what it is that they are studying, or how they should study it. Some of them doubt whether their subject is a branch of physical science at all; others think it would be valueless if it were not. Prof. W. McDougall devotes his presidential address to the Psychological Section to reassuring his faint-hearted colleagues. He insists that it is the business of the psychologist to study his subject by any and every means within his power, without casting side glances at what the students of physical sciences are doing or troubling about what they may be thinking about him. Above all, he should not restrict the scope of his inquiries for the sake of preconceptions about what is correct scientific procedure; the end will justify the means. He rebukes equally the "behaviourists," who want to confine themselves to purely physical methods, and the subjective school, who refuse to make use of observation of physical processes. He rebukes also those who try to belong to both schools with the help of the doctrine of psycho-physical parallelism.

Prof. McDougall conceives of psychology as the study of human nature, and therefore psychologists must take account of all the facts of human nature whether they like them or not. No intelligent discussion of human affairs is possible, as he points out, without the use of such terms as motive, intention, desire, will, responsibility, aspiration, ideal, striving, effort, interest, all of which involve the notion of purposiveness. Any system of psychology which excludes such a notion or explains it away is doomed to sterility and can never find much application to practical affairs. Applied psychology is now a reality both in medicine and industry. Those who have been successful in this field have not been doctrinaire "behaviourists" or subjectivists, but observers who have been ready to study the facts in any way they could and leave the theories to look after themselves. This is very sound advice of Prof. McDougall's, and might well be taken to heart by students of all possible branches of knowledge.

Physiological Aspects of Parasitism.

In his address to Section K (Botany), the president, Prof. V. H. Blackman, dealt with the relationship of host and parasite and their mutual reactions. The differences between animal and plant pathology were first noticed, notably that relating to disease-resistance. In animals, the resistance mostly studied has been acquired immunity, a type not known in the plant world, where the resistance existing is natural immunity. Whatever be the behaviour of individual

cells in plants after a parasitic attack, there is no acquired resistance and no general bodily reaction to disease, hence the application of serum therapy would appear to be precluded. Even if such sera could be prepared, there would be the difficulty of transmitting the substances throughout the plant-tissues and the passing on of the immunity acquired to the new organs which are constantly developing.

With regard to the processes concerned with the achievement of parasitism in plants, the two chief modes of entry, apart from wounds, are through stomatal pores or by actual penetration. The entry through the stoma is clearly the most facile one (though the nature of the reaction which brings it about is still obscure), and it is somewhat of a biological puzzle that any germ-tube should follow the hard road of epidermal penetration. The probability of a negative chemotropism of the germ-tube to its own waste products playing any considerable part in the process does not appear to be very strong, and the evidence for a positive chemotropism to substances diffusing from the host cells is insufficient. It would seem, therefore, that a contact stimulus must play the major part, though it is unlikely that thigmotropism (stereotropism is suggested as a more satisfactory term) is alone responsible for penetration. With regard to the actual mechanism involved, Prof. Blackman and his colleagues have put forward strong evidence for the view that the process is purely mechanical and that enzymes play no part.

The elucidation of the quality of natural infection has been studied particularly in the Erysiphaceæ and Uredineæ. In the latter group, Biffen and his colleagues have shown that resistance in *Puccinia glumarum* in wheat is really the result of hypersensitiveness. The mesophyll cells of the resistant variety are readily infected, but the infected cells react so violently that they are killed and the invading parasitic hyphæ with them. Hypersensitiveness has been shown by Stakman to be the key to resistance of American wheats to *P. graminis f. tritici*. There is no recovery of attacked cells and no production of antibodies either in susceptible or resistant forms. The difference in the behaviour between the cells of the two classes must lie in the differences in the normal physiological processes. Hence this aspect of plant pathology is dependent for its advance on plant physiology.

Academic Freedom.

Principal Ernest Barker's presidential address to Section L (Educational Science), on "The Nature and Conditions of Academic Freedom in Universities," is opportune and much to the point. For one thing, the remarkable growth of modern universities in England in the last two decades has raised the question of academic freedom in a new form, and for another, a little clear thinking upon a subject with so many ramifications is very desirable. Dr. Barker realises the "tangled web of environment" in which the modern university is placed, and does something to unravel it. His analysis is clear, logical, and thorough. At the outset he makes a very proper distinction between the freedom of the teacher and that of the university. He then proceeds to discuss each separately and in some detail.

Perhaps the first part of Dr. Barker's discussion will prove more interesting to the average university teacher than the second. In it he deals with the freedom of the teacher, and, true to his own principles, does not hesitate to express himself with that frankness and freedom which he desiderates. He raises many points and has something of interest to say on most of them. While we may agree with him that a "professor is wise to be severely moderate and master of himself," he will probably agree with us that such wisdom, without occasional relapses, would make academic life, to say the least, somewhat dull. Again, while we may agree with him that "it is difficult to be at once a publicist and a scholar," he will probably agree with us that if professors had become publicists only "in the gravest emergency," public life would have been much the poorer for the limitation. His remarks upon the difficulties which may arise in handling such subjects as history, government, economics, and modern languages are specially pertinent, and it may well be true, as he seems to think, that the cause of academic freedom in the future will be fought with regard to chairs connected with the subjects of politics and economics.

It would have been interesting to have had Dr. Barker's views on university teachers as parliamentary candidates. He seems to think that such candidatures raise "desperate difficulties," but does not state what these difficulties are. Perhaps they are not so great as he thinks, and it may be that there would be advantages largely outweighing them. Here it would seem that Dr. Barker, contrary to his usual practice, passes over an important issue, and one which will become increasingly important in the future. Again, it is curious and apparently illogical for so doughty a champion of academic freedom to suggest that the professoriate should elaborate and *enforce* among themselves a code of professional conduct. It would be immensely interesting to attend a conference or council which set out to draw up such a code! With two qualifications Dr. Barker, so far as the individual professor is concerned, is in favour as a general principle of freedom uncontrolled by any assumption of responsibility by the university.

With regard to the second part of the address dealing with the broader question of the freedom of the whole academic community, Dr. Barker, after a short historical reference, confines himself largely to the discussion of university finance and its general effect upon academic freedom. Here, again, the whole position is thoroughly probed and its many implications carefully considered. The whole address is thought-provoking, exceedingly well handled, and a distinct contribution to a subject of vital importance.

Printed in Great Britain by R. & R. Clark, Limited, *Edinburgh*

SATURDAY, AUGUST 16, 1924.

CONTENTS.

Editorial and Publishing Offices :
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.

Editorial communications should be addressed to the Editor.
Advertisements and business letters to the Publishers.

Telephone Number : GERRARD 8830.
Telegraphic Address: PHUSIS, WESTRAND, LONDON.

Crystals and Cells.

UNTIL very recent years, the addresses of presidents of Sections of the British Association were never made subjects of formal discussion. The address delivered on Monday, August 11, by Sir William Bragg to Section A (Mathematical and Physical Science) of the British Association meeting at Toronto departed from the former custom in being an introduction to a joint discussion with Section B (Chemistry), on crystal structure. Sir William Bragg explained how X-rays have made it possible to analyse the structure of crystals, thus opening up the chemistry of the solid. The X-rays tell us the number of molecules in the crystal unit and the mode of their arrangement, on which, of course, many properties of the substance depend. It may be noted that just as there are *atoms* of silicon and of oxygen, and a *molecule* of silicon dioxide, so there is a *crystal unit* of quartz consisting of three molecules of silicon dioxide arranged in a particular way. There are thirty-two classes of crystals, according to the kind of external symmetry which they display ; but now that he can look into the interior of the crystal, Sir William Bragg finds that there are 230 different modes of internal arrangement. This is a new kind of crystal-gazing.

It has often been asked why a crystal should grow ("Lapides crescunt," said Linnæus) in a solution, especially when the substance in solution is different from that of the crystal, though crystallising in the same style of architecture. There is a welcome beam of light in Prof. Desch's paper on the crystal surface, for it shows that the aplomb of the atoms on the space lattice of the interior, where they are held in position by forces symmetrically disposed, is not shared by those on the surface layer, where there is surface tension and a welcoming, so to speak, of support by accretion from without. At high temperatures, it is noted, the surface tension may be sufficient to cause rounding of the sharp angles of a crystal.

The key-note of the Toronto meeting seems to be "control," for we find Prof. F. W. Gamble, in his presidential address, telling the zoologists that "zoological problems have become problems of control," not so much in the way of restraint as of "quickening." "The infinitely varied animal fabric appears to be the exquisitely balanced individual expression of processes that quicken and restrain." "If to succeed is to come up from below, the actual animal life that succeeds must be but a fraction of the submerged recessive life that experiment reveals. These recessives when artificially bred are no mere cripples, nor disconnected with the evolution of normals. They show us something of the depths of animal nature, and help us to realise that

but for the grace of organic regulation we should be even as they. But the study of such analysis as a branch of zoology leads to an even more striking result. Not only does it reveal the existence of these subnormals, but also *it accounts for the defection of* certain expected offspring. There are non-viable combinations of living substances. These entering the egg that should by expectation produce a male, render the egg incapable of development. That family will be one of daughters only. The existence and the control of lethal factors is one of the most significant discoveries of the underworld."

Prof. Gamble is a strong swimmer and he led his audience into deep waters in his discussion of Prof. Child's hypothesis of metabolic gradients. That is to say, there is in an animal like a Planarian worm a gradation in the intensity of chemical change or metabolism from the head backwards. The rate increases again at a point far down the body and then falls to the tail-end. The second, smaller peak marks the place where the worm divides transversely in its asexual multiplication; it marks the site of the future head of the coming daughter! Prof. Gamble regards the suggestiveness of the evidence in support of the gradient hypothesis as exceeding its conclusiveness for the time being. He goes on to discuss with insight the periodicity of vital functions, the problem of nervous control, the control of environment, and the lightening of the eyes that will come when people take zoology seriously.

In his address to Section M (Agriculture), Sir John Russell discussed "Present-day Problems in Crop Production." One of the big conclusions that has emerged of recent years is that the plant is an even more plastic organisation than we thought; it can be moulded to a notable extent, though within certain—very uncertain—limits. One way of doing this is the Mendelian method of picking out desirable unit characters from plants in which they occur and assembling them in a new plant. The other way is selection, in which a desirable plant is caused to produce seed from which stocks are multiplied. A second generalisation is that the soil is not a fixed, constant thing, but is pulsating with change. The micro-organisms fluctuate continually, and even the mineral part of the soil is not constant in composition. "Modern research work shows that many of the properties determining fertility in soils are due to the soil colloids, and some of the most important are attributable to calcium complexes. These are unstable and are affected by the soil water."

Sir John Russell spoke of the control of the plant, the control of environmental factors (for example, by high-tension electric discharge), the control of soil factors, and the control of soil organisms. But he sounded another note, too seldom heard in these utilitarian days; he spoke eloquently of the value of science for its own sake. "How many farmers know *anything about the remarkable structure of the soil* they till, of its fascinating history, of the teeming population of living organisms that dwell in its dark recesses, of the wonderful wheel of life. . . ." "No one knows much of these things; but if we knew more, and could tell it as it deserves to be told, we should have a story that would make the wildest romance of human imagination seem tame by comparison, and would dispel for ever the illusion that the country is a dull place to live in." This is well said. Trust the agriculturist, fundamental utilitarian as he is, to be loyal to the life that is more than meat.

A familiar experience at meetings of the British Association, especially if one wanders out of "one's own Section," is a coercive abandonment of facts and conclusions which one had treasured as absolutely certain. This holds for the Toronto meeting. Thus it used to be common teaching that the earliest Pre-Cambrian rocks represented the original crust of the earth, formed as it cooled from a molten to a solid condition. This was a comfortable view, for it gave one, so to speak, a geological jumping-off place. But Prof. A. P. Coleman has punctured our illusions in his paper on "Pre-Cambrian Climates." For it seems that there was before the Cambrian a long period of desert conditions and a making of red sandstones; before that was a time of cool moist climate and a making of grey carbonaceous slates; and before that there was a Huronian Ice Age. "Below this, after a profound break, is the Sudbury or Timiskaming series, mostly of water-deposited materials, including 4000 feet of well-banded greywacke and slate, evidently of seasonal origin. This gritty but well-established material and some boulder conglomerates make one suspect a cold and perhaps glacial climate." So the story runs; and the Pre-Cambrian basis, once regarded as primordial, is shown to have behind it a stupendous history.

It is well known that two forms of digestion—intra-cellular and extra-cellular—occur among animals. Intra-cellular digestion, where the food is taken into ingestive cells and then digested, occurs, as Mr. F. A. Potts points out, in sponges, stinging animals, flat worms, and molluscs, often accompanied, however, by the extra-cellular method where the secretion of a digestive juice dissolves the food in the cavity of the food-canal. The latter is the exclusive method in Annelids, Arthropods, Echinoderms, and some smaller phyla. "In the Gastropod Molluscs digestion in the flesh-eating forms is mainly extra-cellular; in the

vegetarians it is largely intra-cellular." In some cases of specialised diet the intra-cellular method is prominent, as Mr. Potts illustrates by the case of the wood-boring Teredo. In some wood-eating Arthropods like termites, in which there is no intra-cellular digestion, the function has been taken over by symbiotic Infusorians.

In an interesting study of sex-development in fowls, Dr. F. A. E. Crew propounds the view that the genetic constitution of the individual determines what may be called the internal environment in the direction of "femaleness" or of "maleness." "In an internal environment of 'femaleness' the embryonic gonad becomes an ovary, in one of 'maleness' a testis. The bird has an ovary because she is a female, a testis because he is a male. The type of plumage is determined by the type of metabolism which obtains at the time of its development, and is not a response to any specific influence of an internal secretion elaborated by the differentiated gonad." The physiological theory of sex, championed by Geddes and Thomson long ago, is having its innings.

Dr. F. A. Dixey's paper on the minute scent-distributing structures in white butterflies is of noteworthy interest. There are secretory cells and distributing scales. The scent-distributing scale is usually a rather highly specialised structure, often in the form of a flattened lamina provided distally with a fringe of chitinous filaments, and proximally with a fine flexible footstalk. The latter expands into an accessory disc, very varied in size and character. The disc is inserted into a specialised socket, within or beneath which are found the cells that secrete the scent. Everything is so minute that it is difficult to be sure how the scent escapes. Dr. Dixey finds no convincing evidence of pores, and inclines to Weismann's view, that the scented material passes from the secretory cells into the disc, the footstalk, and the lamina.

The physiologists continue to discover new rôles for hormones. Thus Prof. W. B. Cannon and Dr. A. Querido find that adrenal secretion is increased in animals when there is liability to lowered temperature by heat loss. The increased secretion brings about an increased metabolism, a chemical calorigenesis, quite apart from the muscular movements of shivering. So the animal has two distinct lines of defence. In another paper by Prof. A. T. Cameron, Dr. T. Ingvaldsen, and Dr. J. Carmichael, evidence is brought forward to support the view that the internal secretion of the thyroid is a compound of thyroxin with some other radical which considerably increases its activity.

Prof. H. Wasteneys and Mr. H. Borsook have succeeded in effecting the enzymatic synthesis of protein in peptic digests of albumin. The maximum synthesis so far obtained has been 39 per cent. There is "incontrovertible evidence" that the material synthesised is of the order of complexity of native proteins. The enzyme responsible for the synthesis was found to be inseparable in every respect from the enzyme effecting the hydrolysis of proteins.

Every one is familiar with the feeling of having seen the same thing before, though one knows that it could not be so. This is the phenomenon of "déjà vu," which Grasset and Freud have explained as due to the activation of an unconscious memory of a real event, a fantasy, or a dream, which in some way resembles the coincident, conscious perception. The problem has been rediscussed by Dr. J. T. MacCurdy, who has found a somewhat analogous pathological phenomenon —the perplexity case—apparently with a similar obsessive suggestion of familiarity. As often happens, the pathological throws light on the normal.

Prof. G. H. Parker has been able to determine the amounts of carbon dioxide excreted by the lateral line nerve of the dog-fish, the sciatic nerve of the frog, and the ventral nerve cord of the lobster. The quiescent frog nerve produced on the average nine-thousandths of a milligram of carbon dioxide per gram of nerve per minute. In active nerve this was increased by about twelve per cent. Weight for weight, the resting frog nerve produces about the same amount of carbon dioxide as the resting human body does.

These, however, are scarcely more than random comments upon a few of the extraordinarily interesting series of addresses and papers presented at Toronto. A more adequate survey of the wide range of subjects brought before the various Sections must be reserved for later issues.

The Metallurgy of Iron and Steel.

(1) *Lehrbuch der Eisenhüttenkunde: verfasst für den Unterricht, den Betrieb und das Entwerfen von Eisenhüttenanlagen.* Von Prof. Dr. Bernhard Osann. Zweite neubearbeitete und erweiterte Auflage. Erster Band: Roheisenerzeugung. Pp. xi+923. (Leipzig: Wilhelm Engelmann, 1923.) 29*s.*

(2) *The Metallurgy of Steel.* By F. W. Harbord and J. W. Hall. (Griffin's Metallurgical Series.) Seventh edition, thoroughly revised. Vol. 1: Metallurgy; by F. W. Harbord. Pp. xii+545+41 plates. Vol. 2: Mechanical Treatment; by J. W. Hall. Pp. xv+553+42 plates. (London: C. Griffin and Co., Ltd., 1923.) 32*s.* net each vol.

WHILST primitive methods of making malleable iron or steel were mainly conducted in such a way that the product was obtained directly from the

ore without a preliminary fusion, almost the whole of the modern product is obtained in the first instance as pig-iron, a readily fusible mixture of iron with carbon, silicon, and other elements derived from the ore and the fuel, these impurities being afterwards removed by processes based on differential oxidation. This roundabout method has proved in practice to have such great advantages, both chemical and economic, that it has become the universal practice. Attempts now being made to re-introduce the old direct process in a greatly improved form have to contend against the fact that smelting in the blast-furnace, at first sight a crude device for extracting iron from its ores, has reached a condition of high efficiency, making it very difficult for a new process to prove any superiority in economy, whatever its apparent theoretical advantages.

In spite of the fundamental importance of the blast-furnace, it has received less attention from scientific metallurgists than the processes for converting its product, the crude pig-iron, into steel. It is true that the pioneer work of Playfair and Lowthian Bell, which gave a scientific basis to the chemical process of ore reduction, has been followed by many interesting researches on the equilibrium between iron, its oxides and the oxides of carbon, but even these reactions are not yet perfectly understood, and most improvements in the operations have been made empirically. Such scientific work as has been done is mostly German, and Prof. Osann's book (1) is greatly superior to works which are little more than catalogues of plant.

The new edition of this treatise, which is the first volume of a comprehensive work on the metallurgy of iron, is of very great interest. Its attractive form and its 550 admirably clear illustrations will make it popular, and it contains information of a detailed kind on the construction and working of the blast-furnace and on such closely connected subjects as the preparation of coke and the utilisation of blast-furnace gas. Certain limitations should be recognised. German, and to some extent American, practice is described, but references to the practice in other countries is only occasional, and not always accurate; the map of the British coalfields on p. 115, for example, failing to show coal in either Yorkshire or Lancashire, and being erroneous in several other respects.

With very few exceptions, all references to literature are taken from *Stahl und Eisen*, so that the remarkable work of the Geophysical Laboratory of Washington on the constituents of slags, the equilibrium diagrams of which are reproduced, is attributed to the writer who abstracted the publications for that journal. The interesting survey of the economic conditions of iron production in the principal countries of the world is dated 1913, the author stating that the present conditions are so chaotic as to make a systematic review impossible.

In addition to its character of an encyclopædia of the construction and use of the blast-furnace, the work is remarkable for the amount of space given to calculations. An effort has been made to give a quantitative treatment of every aspect of the industry, and this part of the work is to be highly commended. The student will find it a profitable exercise to work carefully through a number of the calculations given by Prof. Osann, and in so doing will be impressed by the necessity for maintaining exactly the balance between a number of factors, on which the efficiency of the furnace depends. The English reader will do well to compare the important paper by F. Clements in the Journal of the Iron and Steel Institute for 1920, in which he will find the quantitative data for English blast-furnaces, worked out in detail with all the necessary information for determining the efficiency. With such material before the student, there is no longer any excuse for the academic neglect of the subject of the smelting of pig-iron which has so long prevailed.

There are some defects in the arrangement of the book, a subject being sometimes cut up into separate sections, which are scattered through different chapters without apparent reason. The full table of contents and good index make this defect less serious, although irritating. Casting in the pig-bed only receives a few lines, although machine casting in moulds is rather more fully described, and it is not clear why so essential a part of the process should be neglected. The physical chemistry of the work is rather weak, and occasionally some bad mistakes are made, as in the account of "mixed crystals" on p. 622, but a real attempt has been made to give an account of the chemistry of iron smelting, and the survey of the chemistry of slags is more satisfactory. Revision of the purely scientific sections by a physical chemist would be of advantage; but with this reservation the book may be recommended to metallurgists generally.

(2) The seventh edition of this, the most important English text-book on the manufacture of steel, is greatly enlarged, and now forms two massive volumes, which are sold separately. Since its last revision, progress in the design of plant, in methods of working, and above all in the scientific understanding of technical processes, has made changes in the presentation of the subject to students very necessary. To revise a work of such wide scope, full of illustrations and tables, is naturally a difficult matter, and it is perhaps not surprising to find

that the revision of the first volume, especially, leaves much to be desired.

To give a clear and systematic account of the industry as it exists to-day would have meant the complete re-writing of much of the book, and the easier plan, of interpolating new material at intervals and revising portions only, has been adopted. The consequence is that whilst the new edition of Harbord and Hall must retain its place as the standard work of reference on the metallurgy of steel, the serious student or practical steel-maker will often turn to it in vain for information as to the practice or knowledge of the present day, and at other times will find descriptions of processes or statements of theory which are antiquated, using the word in the relative sense which is natural in connexion with a subject which makes such rapid advances.

The defect is most noticeable on the scientific side. The accounts of the physical chemistry of the iron-carbon system, and of the influence of temperature and other conditions, including the presence of foreign elements, show the grafting of fragments of new knowledge on to the old stock, whilst the student of to-day needs a clear summary of the state of existing knowledge, incorporating the discoveries which have been reached by modern methods. In a work which is less historical than practical, it is disappointing to find so much space given up to dead controversies, the interest in which has disappeared owing to the introduction of new methods. For example, the rival views as to the nature of β-iron and its part in the hardening process have ceased to be of interest since magnetic observations and, above all, the method of X-ray analysis have removed all doubt on the subject. For the same reason an account of the modern method of preparing micro-sections would have been preferable to the long record of methods employed by successive investigators with less perfect technique. Moreover, the scientific study of the relations between the components of molten pig-iron and the oxidising agents which bring about its conversion into steel has made immense progress, which receives no attention in the work before us, the old thermochemical equations which served as a rough guide representing only a part of the story. A good survey of this important field is still lacking, although English chemists have contributed much by their investigations.

Closely connected with this subject is the question of the distribution and influence of segregated impurities and of non-metallic inclusions, the importance of which in determining the quality of steel is now fully acknowledged. The evils due to these causes may be largely eliminated by the choice of suitable methods of casting; but on this matter scarcely any information is given, and the student will have to refer to other works. Another section calling for drastic revision is that dealing with alloy steels. This branch of the industry has developed so rapidly as to make the information given in earlier editions obsolete, and it would have been better to omit the accounts of early work, except so far as is necessary to present the historical aspect of discovery, and to replace them by a modern statement of the alloy steels actually found in use, with a scientific account of their heat treatment and of its relation to constitution. The fact is that the steel industry has passed beyond the stage of empirical control, and has become scientific, and no text-book can be regarded as quite satisfactory which does not indicate the connexion between science and practice. It is to be hoped that a bold effort will be made in the preparation of the next edition to remove obsolete matter, and to replace it by descriptions more nearly representing the actual state of metallurgical science.

The second volume, dealing with the mechanical treatment of steel, is not open to quite the same objections. Such treatment is still mainly empirical, and the scientific calculation of stresses in rolling and forging has only been undertaken by a few persons, whose work is not very generally known. The account of modern plant is adequate, and constitutes a valuable collection of practical information. The chapter on wire, especially wire for ropes, fails to represent modern practice, but in the main new processes are well described. The position of this well-known text-book in metallurgical literature is a deservedly high one, and it has been thought well to direct attention to its shortcomings, in the hope that they will be remedied.

C. H. D.

High Frequency Spectra.

Spektroscopie der Röntgenstrahlen. Von Prof. Dr. Manne Siegbahn. Pp. vi+257. (Berlin: Julius Springer, 1924.) 3.60 dollars.

OF the many fields of physics which have been extensively explored during the past decade, none, perhaps, has yielded a greater contribution to our knowledge of atomic structure than that of X-ray spectroscopy. Since the classical experiments of Moseley in 1913–14, the development of the subject has been rapid, and we have now at our disposal a very extensive knowledge of the X-ray emission and absorption spectra of the elements. The time was therefore ripe for the publication of a volume devoted, almost entirely, to a discussion of the methods and results of

X-ray spectroscopy. The present monograph is all the more welcome as coming from the pen of Prof. Siegbahn, who has contributed more than any other to the development of the technique of accurate wave-length measurements in this region of the spectrum.

Prof. Siegbahn's attitude towards his subject is essentially that of the experimental physicist. His main object is to give a full account of the experimental data at present available, and from these to deduce the laws governing the emission of X-ray spectra. Theoretical considerations are introduced in the interpretation of these laws, but throughout the volume the experimental side is emphasised and theory allocated to a secondary position. In such a volume it is natural to find a very considerable section devoted to detailed descriptions of the various methods used in the experimental work. These descriptions, accompanied as they are by excellent drawings and plates, will prove invaluable not only to those who are interested in the determination of X-ray wave-lengths, but also to all who wish to be acquainted with modern X-ray technique. The author is an acknowledged authority on this subject, and anything he has to say in this connexion is well worthy of consideration.

The discussion of the K,L,M, etc. series follows more or less conventional lines. Very complete tables of the latest accurate measurements are given, both for the emission and for the absorption spectra. At present the accuracy of the determination of X-ray wave-lengths must depend on that of other physical constants, but it is no small achievement that, after so short a time, it should be possible in many cases to determine relative wave-lengths to six significant figures. The author emphasises certain experimental work which has so far not received attention in other books on the subject. Most noticeable, perhaps, in this connexion, is the account of the remarkable experiments of Lindh and others on the dependence of the absorption bands of such elements as chlorine and sulphur on their state of chemical combination. This is the first definitely established case of the influence of molecular combination on these phenomena. Now that it has been shown that the valency of the atom in the molecule affects the position of the edge of its absorption band, physicists and chemists alike will await with interest further work in this direction. The whole treatment of the absorption and emission spectra is excellent. Not only are tables of wave-lengths given but also of frequencies (ν/R and $\sqrt{\nu/R}$); a few obvious inaccuracies have crept into these tables, but they are not such as are likely to lead to any confusion.

An admirable section is devoted to the more theoretical side of the problem. Mathematical treatment has been avoided, but the description of the principles laid down by Bohr and Sommerfeld is sufficient to enable the reader to follow with interest the extraordinarily successful manner in which theory has kept pace with experimental progress. The existence of doublets of constant frequency difference, the connexion between one series and another, the variation of frequency with atomic number and other properties of X-ray spectra, are discussed and shown to be natural consequences of Bohr's atomic model. From the experimental data, Prof. Siegbahn demonstrates how it is possible to determine the various energy levels in the atom, and how the levels so determined provide a remarkable confirmation of the distribution of the electrons in the atom suggested by Bohr from other considerations. The fact that all the lines which these energy levels suggest as possible do not occur in the observed spectra is shown to lead to a selection principle similar to that which holds for the visible spectrum. The author has been most successful in his endeavour to present the theoretical aspect of his subject with a maximum of simplicity. The reader can scarcely fail to be impressed by the remarkable way in which a theory, formulated initially to explain the visible spectrum, is shown to be immediately applicable to a region of the spectrum where the frequencies of the radiations are some ten thousand times greater. Prof. Siegbahn makes it clear that much work still remains to be done before all the facts described in the earlier chapters are satisfactorily interpreted. Particularly interesting, as a suggestion of further lines of development, is his account of Wentzel's attempt to explain the more complicated K spectra of the lighter elements as due to the existence of atoms from which more than one electron has been removed.

In the concluding chapters the author deals with the "white" radiation and with the more indirect methods which have been applied to X-ray spectroscopy, especially with the determination of energy levels by means of β-ray spectra and ionisation potentials. The work in the latter direction has been most successful in helping to bridge the gap between the X-ray region and the extreme ultraviolet. In the form of appendices are given some useful tables and an excellent bibliography.

Prof. Siegbahn is to be congratulated on having produced a volume which is not only a necessary addition to the library of the X-ray specialist, but is also to be heartily recommended to all who are interested in the advance, experimental and theoretical, in one of the most productive fields of modern physical research.

Lord Avebury's Life and Influence.

The Life-work of Lord Avebury (Sir John Lubbock), 1834–1913. Comprising Essays by Sir Bernard Mallet, Sir Arthur Keith, Dr. A. Smith Woodward, Prof. J. Arthur Thomson, H. St. J. K. Donisthorpe, Dr. A. C. Seward, Sir Michael E. Sadler. Edited by his daughter, the Hon. Mrs. Adrian Grant Duff. Pp. vii+261. (London: Watts and Co., 1924.) 6*s.* net.

THE book under notice contains a short memoir of the late Lord Avebury, and a series of appreciations of his very numerous activities by seven experts. Lord Avebury was an interesting personality, and he covered so many and so varied interests that it requires a symposium to estimate the value of the work he did.

The first of these experts is Sir Bernard Mallet, who dwells upon the political and economic work Sir John Lubbock did whilst he was a member of Parliament. When he was first invited to become a candidate he summed up the objects he wished to achieve as follows: "(1) To promote the study of science both in secondary and primary schools, (2) to quicken the repayment of the National Debt, and (3) to secure some additional holidays and to shorten the hours of labour in shops." It is remarkable how by quiet and steady persistence he in time achieved those reforms which he set out to accomplish. His name will ever be associated with bank holidays. Sir Bernard sums up his power as a politician as follows:

Sir John Lubbock's whole attitude towards economic questions was characterised by the same sound judgment and common sense. He was, as I have mentioned, in full sympathy with the best economic opinion of his day on fiscal policy, Free Trade, municipal trading, and so on; and in his various addresses and articles on such questions his touch is so sure and confident that a reader might almost imagine that his views had been adopted wholesale from text-books. His scientific habit of mind, no doubt, combined with his practical experience of business, gave him more than ordinary facility in such matters: but he had furthermore the power observable in men of executive capacity of arriving rapidly and without any apparent process of thought at conclusions which, once formed, were apt to remain unquestioned in his mind. This probably accounts for his remarkable clearness in exposition.

Lord Avebury's remarkable achievements in anthropology are dealt with by Sir Arthur Keith. In the middle of the last century, from the late 'forties to the 'sixties, a small company of Englishmen with whom Lubbock was associated—he was quite a boy, for he entered his father's bank in 1849 at the age of 15—entirely revolutionised the idea of the history of man. Constant contact with Charles Darwin, a neighbour of his in Kent, had widened his outlook and that of his fellow-workers; and perhaps the most distinguished of the many distinguished pieces of work that Lord Avebury accomplished was in his "Prehistoric Times" and "The Origin of Civilisation"; both of these passed through repeated editions and are still classics. The words of Sir Arthur Keith are eminently true when he writes: "Let us have done, once and for all, with the prevalent notion that his books on the pre-history of man are the mere accomplishments of a clever compiler. He was an original thinker of a high order."

As a geologist Lord Avebury was chiefly interested in prehistoric man, and his geological publications were not highly specialised in other fields, but his knowledge of geology gave a good background to many of his widely read books. "The Scenery of Switzerland," for example, was much more than a mere 'compendium or abstract of the works of the Swiss geologists whom he quoted. He wrote from first-hand personal knowledge, and he always had an eminently readable style, so that this book has added greatly to the pleasure of the numerous frequenters of "the playground of Europe."

A very brilliant study of Lord Avebury's work as a zoologist is written by Prof. J. Arthur Thomson. Although his published monograph on the Collembola and Thysanura, an obscure group of insects, is still a standard work of reference, his chief fame rests on his amazing investigations into the behaviour of animals. He was, indeed, as Prof. Thomson says, "the pioneer of the experimental study of animal behaviour." His observations on the colour-sense of bees, the homing of ants and bees, and the behaviour of wasps started a new chapter in the history of experimental zoology. There is a special chapter dealing with his fascinating studies on ants by Mr. Donisthorpe.

Lord Avebury's researches in botany are dealt with by Prof. Seward, who recounts the ceaseless work which he did on the interrelation of insects and plants, the methods of pollination, the form of leaves, buds, and stipules, and last of all on seedlings. His love of beauty and his great gift of exposition are evidenced in all his writings, but nowhere more so than in his writings on the plants he loved so well.

Lord Avebury's business training doubtless enabled him to apportion his time so that no one minute was wasted. How one man could have got through so much, how he could have made so many researches and so faithfully investigated Nature in so many phases is difficult to understand. Doubtless he had many helpers. But this total output, as recorded and appreciated in this book on his life work, is literally amazing, especially when one remembers that he was actively engaged as a successful banker during most of his life.

Our Bookshelf.

The Cultivated Evergreens: a Handbook of the Coniferous and most important Broad-leaved Evergreens planted for Ornament in the United States and Canada. Edited by L. H. Bailey. Pp. xvii + 434 + 48 plates. (London: Macmillan and Co., Ltd., 1923.) 31*s.* 6*d.* net.

THIS handsome volume was compiled for use in the United States and Canada by fourteen American experts in botany, horticulture, and allied subjects; but it will also be of service on the eastern side of the Atlantic, as nearly all the species dealt with can be seen in English parks and gardens. The great diversity of the British climate allows us to grow, in one part or another of these islands, an amazing number of exotic plants, imported from almost every region outside the tropics.

The greater part of the text is concerned with one class of evergreens, the Coniferæ; but the five genera, Larix, Pseudolarix, Taxodium, Glyptostrobus, and Ginkgo, which happen to have deciduous foliage, are not excluded on this account. The other class, comprising the broad-leaved evergreen trees and shrubs, seems to be more sparingly cultivated in the United States than in Great Britain; and only 25 species are selected for description, though some others are briefly mentioned. Acid soils, which are an essential requirement for the proper growth of a considerable number of broad-leaved evergreens, are the subject of a special article by Prof. F. V. Coville, whose experiments should greatly interest cultivators of Rhododendrons.

In the main part of the book, conifers are considered from nearly all points of view, except that of timber production. The use of the different species and varieties for ornament and shelter is the main consideration. A series of articles deal with their effects in the landscape, and their adaptability to different soils and situations. Other articles are concerned with modes of propagation, nursery management, cultivation, attacks of insects, diseases, injuries of all kinds, fungicides, tree surgery, etc. The information given on these subjects by the various experts contains many valuable hints on the choice, cultivation, and care of coniferous trees.

The botanical part of the work is due to Alfred Rehder, the systematist of the Arnold Arboretum. In this establishment there are fine collections, both of living trees and of dried specimens, which have enabled him to draw up accurate descriptions of the conifers in cultivation. He has also provided keys for the genera and species, which render identification easy, even in the absence of flowers and cones. The botanical descriptions are elucidated by nearly 100 engravings in the text. Conifers are very varied in form and colour; and their choice for landscape effect depends largely on a proper knowledge of the habit of each species and variety when fully grown. This is well illustrated by 48 full-page plates, which depict groups and individual specimens growing in New England. These plates are worthy of study by landscape gardeners.

A check-list of all the woody evergreens that are offered for sale in the United States is given at the end of the book, which will serve as a suggestive planting list. There is also an adequate index. We have no hesitation in characterising this handbook as a useful addition to the literature of conifers.

The Modern Theory and Practice of Pumping: a Treatise on the Application of the Reynolds-Stanton Law of Viscous Flow to Modern Pumping Problems and the Flow of Liquids through Pipes. By Norman Swindin. Pp. 364. (London: Ernest Benn, Ltd., 1924.) 42*s.* net.

THE first part of this work is devoted to a general consideration of viscosity, of the motion of viscous fluids, and of the resistance to flow in pipes, with special reference to the relationship between the many empirical formulæ of the exponential type which have been evolved in the past, and the dimensional formula of Reynolds.

The introduction deals briefly with the history of modern hydrodynamics, outlining the relationship between the behaviour of the perfect fluid of the mathematician and of a viscous fluid. Chapter ii. deals with industrial viscometry, with special reference to the liquids with which the chemical engineer may be required to deal. Chapter iii. gives a précis of Reynolds's discussion of the two manners of motion of a fluid, together with later extensions of the theory, and Chapter iv. gives examples of the application of the Reynolds's function in industrial problems. The treatment of this part of the book is excellent, and the various points of application to the problems of the chemical engineer are well brought out.

The second part of the work deals with the many types of pump in use for pumping corrosive, gritty, solid-laden, and viscous liquids such as are not in general handled by the hydraulic engineer. Chapters are devoted to the ram pump, the centrifugal pump, the rotary pump, the air-lift, the displacement pump, and to miscellaneous pumping appliances, particular attention being paid to those types which have been devised to meet special conditions.

While no great space has been devoted to a discussion of the theory of operation, this is adequate for the purpose in view. Special reference must be made to the section dealing with the air-lift pump. This forms one of the most satisfactory discussions yet published of this important but somewhat neglected type of installation. A chapter is devoted to pipe lines and fittings, and another to the pumping of oil for the oil fuel and petroleum industry. In view of the special difficulties involved in pumping such fluids through long pipe lines, this chapter is likely to be of much value.

The book should certainly find a place in the library of every chemical engineer, while engineers in general hydraulic practice will find much that is stimulating and of interest in its pages. It is well printed and excellently illustrated. A. H. G.

Thermochimie. Par Prof. F. Bourion. (Collection de Physique et Chimie.) Pp. xii + 363. (Paris: Gaston Doin, 1924.) 25 francs.

THE science of thermochemistry owes most of its experimental data to the work of Thomsen, from 1853 onwards, in Copenhagen, and to the work of Berthelot in Paris from 1865. It was originally inspired by the

idea that the amount of heat liberated in a chemical action was a measure of the energy available from this source, but this is only correct at the absolute zero; at all other temperatures, therefore, endothermic actions can occur, and it is no longer possible to predict from the thermochemical data alone in which direction a chemical action will proceed. On the experimental side also, the science has been limited by a standard of accuracy far lower than can be attained in other physical measurements. This lack of accuracy is the more to be deplored since the heats of formation of organic compounds are based upon the differences between relatively enormous heats of combustion; and the most interesting data (*e.g.* the heats of formation of isomers) contain even larger percentage errors than the heats of combustion through which they are determined.

It is, however, of interest to know that recent developments, in the original laboratory of Berthelot, have led to a very great improvement in the degree of accuracy of the measurements. These are now being obtained within about 1 part in 1000 by using a completely enclosed apparatus, in which evaporation from the surface of the calorimeter and other disturbing factors are eliminated. It is therefore natural that interest in thermochemistry should once again have been aroused in France, and that the latest text-book on the subject should be of French origin. Prof. Bourion has not himself made any important contributions to thermochemistry, but he is familiar with the work that has been done by other investigators, and his book will obviously be consulted by all those who wish to know the present position of the subject.

La télégraphie sans fil: ses applications en temps de paix et pendant la guerre. Par Julien Verdier. Pp. viii + 412. (Paris: Gauthier-Villars et Cie, 1924.) 35 francs.

To every radio engineer who desires to learn the latest practical advances made in radio communication in France we can recommend this book. The historical introduction is not very good and has perhaps a national bias, while the theoretical chapter is too sketchy to be of use to any one but an expert. But the chapters describing practical applications, radio communication during the War, and the French radio stations, contain much novel matter. France has built the two most powerful stations in the world, Melun and Croix-d'Hins. The radio centre at Sainte-Assise is perhaps the most perfectly organised. Methods of using radio waves for discovering masses of metal near the surface of the earth are described. Many of the important radiograms issued during the War are now published for the first time, and the conversations between the Eiffel Tower and Nauen will be instructive to the future historian. The radiograms issued just before the Armistice are highly dramatic.

The French radio system is divided into three distinct services, (1) the Service of the Interior, (2) the Radio Maritime Service, and (3) the Colonial and International Service. The first, which is used for official, special press, meteorological, etc., messages and for time signals, relieves considerably the ordinary telegraph service. Broadcasting comes under this head. The Radio Maritime Service maintains communication with ships at sea and is regulated by the International Rules adopted at London in 1912. Full lists are given of the Colonial and International stations with which there is regular communication. In the last chapter, both the French and the International Rules for radio work are given in full.

Théorie générale sur les courants alternatifs. Par M. E. Piernet. (École d'électricité et de mécanique industrielles.) Fascicule 1. Pp. x + 100. (Paris: Gauthier-Villars et Cie, 1924.) 12 francs.

THIS book explains clearly the principal theorems of the theory of polyphase currents. The mathematical student who has a knowledge of French will have no difficulty in understanding it. The theorems given form an excellent basis which he can use for extending his knowledge. It will be useful, however, to make a few criticisms. When defining the instantaneous power in a circuit (p. 13) the author talks about the quantity of energy *instantaneously* given to the circuit. He defines also the watt current and the wattless current. The reader gets the impression that the current has more to do with the power than the electromotive force. A formal proof is given of the "equivalent" sine wave, and it is concluded that it can in general be used instead of the actual wave. Many practical engineers do make this assumption, but in some cases it will lead to very erroneous results. The so-called "equivalent" sine wave has a different area from the actual wave. The magnetic flux induced in a transformer, for example, when the two waves are applied at the primary terminals, will be different and so also will be the consequent losses in the core. The experimental method of analysing a wave is described, but we do not think that the analytical method given will be of much use. In the last chapter the theory of rotating magnetic fields is discussed in a way that will appeal strongly to the mathematician. Much of this book might with advantage be included as practical examples to illustrate the theory in a mathematical treatise on the calculus.

A Shorter School Geometry. By H. S. Hall and F. H. Stevens. Part 1. Pp. x + 164 + iv. (London: Macmillan and Co., Ltd., 1924.) 2*s.* 6*d.*

THIS volume is much more than a revised edition of the well-known course of "School Geometry" by the same authors: there are differences alike in matter, plan, and presentation so substantial that it may almost be regarded as a new text-book. The authors have followed many of the recommendations put forward in the recent report issued by a Committee appointed by the I.A.A.M. We notice, however, that they have included in the text "proofs" of the fundamental congruence theorems but have excluded "proofs" of the fundamental parallel theorems. This is a curious compromise which it is unlikely will stand the test of time. Both groups of fundamental properties are treated informally in an introduction which runs to 42 pages and also includes some mention of similarity; the latter, however, might with advantage be discussed in greater detail. There is much to be said for developing informally the general principle of similarity with as much emphasis as is now given to the general principle of congruence. The exercises have been increased in number, particularly those of a numerical character: the clearness of the type and the diagrams deserve a special word of praise.

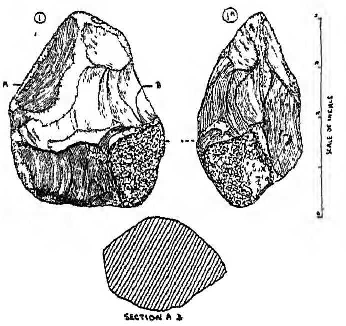
Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Further Discoveries of Ancient Flint Implements at Cromer.

FOLLOWING upon the discoveries of flint implements referable to the Cromer Forest Bed Series of Norfolk, the Trustees of the Percy Sladen Fund very generously provided funds for the further examination of these and of other associated deposits. The first part of this research is now completed, and has, in my judgment, established the occurrence of flint implements of Early Chellean types at the base of the Cromer Forest Bed, and of Late Acheulean types in some of the glacial gravel above the Contorted Drift. As will be remembered, there was discovered upon the foreshore at Cromer a large series of ochreous specimens, which, while not actually *in situ*, was, from the whole circumstances of the case, referred by me to the lowermost horizon of the Forest Bed.[1]

It was obviously necessary to endeavour to ascertain by digging if similar ochreous flints occurred in place in some deposit beneath the beach, between the foreshore and the cliffs, at the site where the discovery was made. Such excavations were attempted, but, unfortunately, the water-logged condition of the sand and shingle forming the beach was such as to make impossible any digging in a downward direction, and the work had to be abandoned. Associated with the ochreous specimens upon the foreshore, was found another series of artefacts of a totally different character. These latter flints are usually of a glossy black colour—giving them an appearance of having been black-leaded—and their forms and flaking are clearly divergent from the ochreous pieces.



FIGS. 1 and 1A.—Early Chellean hand-axe from foreshore, Cromer.

The occurrence of large quantities of such flints upon the Cromer foreshore, beyond the seaward extension of the beach, is to be explained only on the supposition that, at one time, there existed a bed, or beds, containing these specimens, and that the action of the sea has gradually removed the ferruginous or other material forming the deposits, leaving only the heavier and insoluble residue of flints and other objects intact. This supposition is supported by the following facts. A prolonged examination of the contents of the beds forming the cliffs and the foreshore of the north-east coast of Norfolk has shown that the great bulk of the flints referable to these various deposits differ markedly, and that, for example, it is not possible to mistake specimens in the glacial gravels for those coming from the Forest Bed. Further, a considerable number of the foreshore specimens have, attached to some portion of their surfaces, the remains of a highly ferruginous sandy deposit, which clearly formed part of the bed in which at one time the flints were embedded. Moreover, upon the foreshore, exposed at low water at East Runton—about 2 miles westward of Cromer—there are to be seen large areas of a highly ferruginous bed, the sandy content of which corresponds precisely, in appearance, with that adherent to the specimens found at Cromer. Lastly, an examination of the East Runton deposit demonstrates that it contains implements and flakes comparable, both in colour and in technique, to the ochreous and to the black-leaded series of Cromer. The former assemblage is certainly not so deeply ochreous as that collected upon the Cromer foreshore, but this is a minor difference due, no doubt, to the fact that, at the latter place, the flint-containing bed was richer in salts of iron than that exposed at East Runton. The remains of this bed at this place are surrounded by large numbers of flints, such as occur upon the foreshore at Cromer, and it is abundantly clear that these specimens have been washed out of the deposit to which they lie in such close proximity.

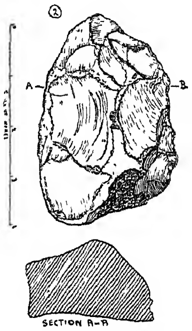
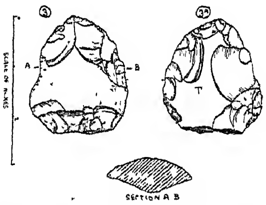


FIG. 2.—Early Chellean hand-axe from foreshore, Cromer.

There can be no doubt that this East Runton deposit, which rests upon the chalk, underlies (*a*) an accumulation, representing probably the Estuarine Gravel, containing large mammalian bones referable to the Cromer Forest Bed, and (*b*) the immense glacial deposits and chalk erratics exposed in the cliff at this spot. The implementiferous bed is about 18 inches in greatest thickness, and contains a large number of flints, many of which exhibit the well-known appearance of those found in the Stone Bed beneath the Weybourne Crag, together with pieces of quartz, fragments of bone, and some shells. In fact, at first sight, the deposit bears a very close resemblance to the Sub-Weybourne Crag Stone Bed, material from which it undoubtedly contains, but an examination of the contents leads me to believe that the accumulation must be referred to a later period than that of the Sub-Crag Stone Bed, namely, to the earliest Cromer Forest Bed Stage. Many of the flints found in the East Runton deposit exhibit well-marked striations upon their flaked surfaces.



FIGS. 3 and 3A.—Late Acheulean hand-axe from glacial gravel, Cromer.

In order to give students of prehistoric archæology an opportunity of forming a judgment as to the kind of implements found during my recent researches, I give here illustrations (Figs. 1 and 1A and 2) of two specimens of Early Chellean implements from the foreshore site at Cromer. Both of these are of the "black-leaded" variety. The majority of the Early Chellean "hand-axes" (of which I have now upwards of 40 examples), referable to the base of the Cromer Forest Bed deposits, are of the batiform type—having one face more or less flat, and formed usually by a single flake-removing blow, while the other face is convex and exhibits numerous flake-scars. This peculiarity applies both to the ochreous and to the "black-leaded" specimens I illustrate in Fig. 2 an implement of the batiform type, while in Figs. 1 and 1A are shown two views of a specimen of a much rarer form, which approximates to the platessiform type, and is more or less rhomboidal in section.

[1] Moir, J. Reid "The Great Flint Implements of Cromer, Norfolk." (W. E. Harrison, Ancient House Press, Ipswich.)

It is of much interest to note that Early Chellean implements, which correspond in all their main features to those found at Cromer, occur in the lower portion of the well-known palæolithic gravel at Warren Hill in north-west Suffolk. The specimens in this deposit, which show marked signs of transport, exhibit a different coloration and general appearance from the Cromer hand-axes, due to the differing conditions to which they have been subjected. The last-named specimens show a peculiar wearing down of their ridges, and outstanding portions, which is not usually found, so far as my knowledge extends, associated with river-gravel implements With the hand-axes of the Cromer Forest Bed has been found a large series of scrapers of various kinds, and also many flakes—which, however, cannot be described in this communication, owing to limitations of space.

In the glacial gravel capping the cliff at Cromer, and at East Runton, have now been found two implements of Late Acheulean type. Both of these have been discovered by Mr. Guy Maynard, who on several occasions has accompanied me to Cromer. One of the specimens mentioned, a small and typical hand-axe, exhibiting "basket-work" patination, is illustrated in Figs. 3 and 3A (the surface marked T in Fig. 3A is of thermal origin). When the Cromer research is completed, I hope to publish a full and detailed account of the whole of the results obtained.

J. REID MOIR.

One House, Ipswich.

The Theory of Hearing.

I SHOULD like to express my agreement with the letters which Sir Richard Paget and Mr. Wilkinson have written (NATURE, July 19, p. 87) under the above heading. It seems to me that even if Prof. Scripture is right in stating that the movements of the vocal chords cannot be analysed, he is not justified in concluding that the aerial vibrations thus set up are not analysable either. There is, I believe, unassailable evidence that such a conclusion would be wrong; because all workers in this field from Helmholtz and McKendrick to Miller and Bevier are in agreement as to the success of such analysis. Their analyses differ somewhat, it is true, but individual and national peculiarities in vowel production probably account for these. With regard to the piano experiments, I fear that Prof. Scripture (NATURE, August 9, p. 194) has not appreciated the fact that his criticism of Sir R. A. S. Paget and Mr. Wilkinson, namely, that "what a person hears is chiefly what he expects to hear," applies with equal force to himself.

Returning to Prof. Scripture's main argument for one moment, I should like to put a number of questions to him. (1) What experimental proof has he for the statement that the equation for a single laryngeal puff is $y=a.e^{-ct}$? (2) Are not the variations of pitch of the voice limited in most individuals to about two octaves? (3) Are the variations in pitch in speech more rapid than two octaves per second? If (2) and (3) are answerable in the affirmative, then the results of my experiments quoted in my last letter to NATURE would apply, namely, that a relatively small group of resonators will be affected at any one moment, and that the group thus affected will shift as a whole according to the change in pitch of the voice.

Lastly, may I give some notes on the important point raised by Mr. Wilkinson, namely, as to the damping coefficient of the ear resonators. To commence with, I should like to point out that two additional factors are involved in any attempt to determine the physiological behaviour of the ear, namely, (1) the least amplitude of vibration of resonators of different pitch which will just cause noticeable stimulation of the corresponding hair cells, and (2) the least perceptible difference between the amplitudes of the resonators set up by two immediately successive tones—in other words, the absolute and difference thresholds respectively. It is not difficult to see the importance of these two factors. Two examples will suffice: (1) The ability of an individual to judge if two tones of the same pitch have the same intensity is determined not alone by the difference in amplitude of vibration which these set up in the ear resonators, but also on the ability of the hair cells to perceive the difference. (2) The time taken for silence to follow the cessation of a tone depends not only on the rapidity with which the resonators return to rest, but also on the amplitude of the vibrations to which the hair cells cease to respond.

There are thus three quantities to be determined, the two thresholds mentioned above and the damping coefficient of the resonators. By methods to be described fully elsewhere, I have obtained the following provisional values for these quantities:

The absolute threshold is reached when the amplitude of swing of the resonators falls below 5·8 per cent. of the previous steady value.

The difference threshold is reached when the amplitude of swing of the resonators falls or rises by more than 2·6 per cent. of the previous steady value.

From the damping coefficients the following tuning and persistence coefficients were obtained:

Tone	Tuning Coefficient.	Persistence Coefficient.
	Per Cent.	
128	9·0	6·5
256	7·5	8·0
512	6·3	9·5
1024	5·4	11·0

The tuning coefficients are the percentage difference of frequency between that pitch which is in tune with a given resonator and that which will produce one-tenth the amplitude of swing which the intune one would have done.

The persistence coefficient is the number of complete swings which would occur in the time taken for the amplitude of the resonator to fall to one-tenth its previous value.

From these values it is possible to make a number of calculations, which can then be compared with the results of experiment. For example, one can calculate the difference of pitch necessary for the differentiation of two successive tones or the time taken for silence to follow the cessation of a tone.

Tone.	Calculated just Perceptible Difference of Pitch in Cents.	Calculated Time to reach Silence in Hundredths of a Second.
128	1·5	6·9
256	1·3	4·3
512	1·1	2·5
1024	0·9	1·5

These calculated pitch difference values compare well with experimental ones given in the table below, except with 120 vibrations per sec., at which the calculated value is too beneficial.

Tone.	Observed just Perceptible Difference of Pitch in Cents.	
	Delezenne.	Kulpe.
120	6	...
260	...	1·24
500	1·0	...
1000	0·84	...

The values for "the time to reach silence" would permit a shake or trill of the following number of tones per second to be clearly heard.

Tone.	No. of Notes per Second clearly audible.
128	14·5
256	23·0
512	40·0
1024	67·0

Unfortunately, I know of no extended experimental results by which these values can be checked. They fit, however, Helmholtz's statement that a shake or trill of 10 notes per second, which is clear for tones above about 110 vibrations per sec., ceases to be clear below that pitch.

With regard to the least and greatest differences of pitch between two tones for audible beats, the calculated and observed values appear to fit well. Perhaps I may finish this letter by asking Mr. Wilkinson if these values also fit in with the data at his disposal.

Lastly, being a physiologist, I cannot agree with Prof. Scripture's suggestion (p. 194) that the resonance theory is unthinkable to those who work with delicate human tissues. Neither can I take seriously his proposal that the resonance theory be abandoned and his own substituted. The resonance theory has so far passed every test that I have put to it. Why then think of abandoning it? If I had any doubts lurking in my mind concerning it, or if I thought that it had need to fear rivals, I might, with the editor's permission, tell Prof. Scripture exactly what I think of his theory. But, as neither is the case, I feel there is no need for me to do this. If I have a regret, it is that Prof. Scripture is not as familiar with resonators as he apparently is with delicate human tissues.

H. HARTRIDGE.

King's College, Cambridge.

On Early Sexual Maturity in the Molluscs, *Syndosmya alba* and *Cardium fasciatum*.

IN November 1920, good numbers of the mollusc *Syndosmya alba* round about 15 mm. in length and sexually mature were taken by dredging in the Black Deep near the Edinburgh Lightship. The occurrence of this bivalve, practically on the spot where munitions had recently been dumped, is a matter of much interest, so that observations on the life-history of this form are worth recording. It was suspected at the time that the specimens taken in 1920 were at least six months old, as estimated from material obtained in the sea experimentally, but recently the present writer had the good fortune to obtain a good fall of young ones of this species in a cage which had been in the sea in the River Blackwater in the Thames Estuary area about eight months, *i.e.* from October 22, 1923, to June 7, 1924. In this case the valves of *Pecten maximus* and *Ostrea edulis* were strung on tarred rope in pairs, so that pairs of the shells were in the same relative position as in life. In the cavity of these shells a certain amount of mud accumulated, and in this nidus young Syndosmya settled at some time later and grew to a size varying from 6·5 to 12·0 mm. in length. Individuals about 8·0 mm. in length were found to be approaching sexual maturity.

An artificial fertilisation was made on June 8, 1924, from a ripe male and female 11·5 and 12·0 mm. long, respectively, after the eggs had matured in the sea-water for one hour. It was found that in less than five minutes the ripe egg threw out a large very transparent membrane; in about three hours embryos in two to seven celled stages occurred, and in twenty-four hours a ciliated larva; in less than forty-eight hours a fully formed trochosphere developed with a fine apical tuft resembling the similar stage in the Gastropod, Patella. In a similar experiment male and female *Cardium fasciatum* 8·3 and 8·5 mm. long were obtained sexually mature, and yielded a thin-shelled veliger in the double egg-case in less than forty-eight hours, and a good shelled larva in four days.

Similar material of Syndosmya and Cardium had been obtained in previous years in a period of three to four summer months, but in circumstances where age determination was less certain.

It is a very difficult matter to grow animals of this kind in the sea and be absolutely certain of their age; in the experiment quoted above there is a faint possibility that some of the Syndosmya may have been washed between the shells, although the chance is very remote, as the cage in which the shells were fixed was specially raised 3 feet from the bed of the sea. An experiment has been devised, however, to obtain more information. A point of interest about the early trochosphere of Syndosmya is that it changes its direction of revolution in the egg-capsule in a rhythmical manner which apparently varies with the physical conditions.

At the same time as Syndosmya and Cardium were growing to sexual maturity, European oysters (*O. edulis*) settled in a similar situation and grew to a size of more than one inch long by one inch deep, while Portuguese oysters (*O. angulata*) grew to as much as 32·6 mm. long by 44·0 mm. deep, although the young oysters of both kinds were mostly less than half an inch long at the end of last year's growth. Thus, although the sexually mature Syndosmya and Cardium cannot be more than eight months old, there is good reason to infer that they may be much younger, especially as the shells showed mostly no indication of a winter ring. It is probable that both these forms mature in summer in about three or four months.

J. H. ORTON.

Marine Biological Laboratory,
Plymouth, July 24.

The Reported Transmutation of Mercury into Gold.

IN your account of the reported discovery, by Prof. Miethe, of the transmutation of mercury into gold (NATURE, Aug. 9, p. 197) by the prolonged action of a high-tension electric current upon it, you seem to consider only one way, and that not the more obvious way, of effecting such a transmutation, namely, by striking out a hydrogen ion from the nucleus by some powerful method of disruption. There is another method of effecting such a change, namely, by attaching an electron to the mercury nucleus. Indeed, for some time before Prof. Miethe's announcement it has been clear to me that, by passing a sufficiently high tension discharge through mercury vapour, not merely that such a transmutation might occur, but that it was inevitable, unless our present views of atomic structure are radically at fault.

For consider the collision of high-speed electrons with mercury atoms. A small proportion of these

electrons must be directed upon the nucleus. If they possess sufficient energy to penetrate the external levels of electrons in the mercury atom, they must reach the positively charged nucleus and be captured by it. Since the loss of an electron (as a β-ray) by the nucleus of an element in the radioactive disintegration of an element results in the atomic number of the element in question being increased by one, the gain of an electron by an atomic nucleus must result in the diminution of the atomic number by one. This is quite general. In the case of an isotope of mercury of atomic number 80, the product will be an isotope of gold of atomic number 79. Upon existing knowledge it is simply a question of (1) the potential sufficient to drive the electron through the outer levels of electrons surrounding the mercury nucleus until it comes within the sphere of attraction of the powerfully charged nucleus; (2) whether the exceedingly small fraction of direct collisions with the nucleus that is to be anticipated will be sufficient to enable the gold produced to be detected.

As regards the first, it may be expected that the repulsion of the external shell of mercury electrons will diminish rather than prevent altogether the chance of the radiant electron reaching the nucleus: for once the shell is penetrated, the resultant force on the radiant electron must be on the average an attraction. Hence I had arrived at the conclusion that, not the transmutation, but the chemical detection of the gold produced, would probably be the more formidable experimental difficulty.

Of course, I need express no opinion on the correctness of the experimental results recorded, which naturally will have to be very rigorously confirmed by further work. I merely wish to point out that no atomic disruption is necessarily involved, and that, so far from conflicting with existing knowledge, the result in a sense follows naturally from it, the only question being one of the sensitiveness of the experimental methods of detecting gold.

FREDERICK SODDY.

Oxford, August 9.

The Transmission of a New Plant Virus Disease by Insects.

IN a paper read to the Imperial Botanical Conference held in London this year, I have described a variegated condition of a number of Graminaceous plants, characterised by chlorosis of the leaves in narrow broken stripes parallel to the veins and a reduction in the power of growth of the plant. In maize it has been recognised for many years as a factor limiting production in the coastal and midland areas of Natal, and was described as long ago as 1901 by Fuller (First Report, Government Entomologist, Natal). Similar conditions are found in sugar cane and a number of other grasses.

I have given evidence in the paper mentioned for the belief that this variegated condition is a disease of a type similar to the now well-known mosaic disease of sugar cane, maize and other grasses, but is not identical with it. These conclusions were at that time based upon general observations and lacked evidence of experimental transfer. Recent work upon insect-transmission of the disease occurring in maize affords confirmation of the conclusions originally reached.

In a series of experiments I have been able to demonstrate the ability of the adults of a Jassid leaf-hopper, an undescribed species of the genus Balclutha, to produce the disease in healthy maize plants when transferred to them from diseased plants. Hoppers taken from healthy plants have failed to produce the disease. All plants have been protected from outside infection for the whole period of the experiment, and no control plants have developed the disease. The role of *Aphis Maidis* Fitch as the vector of mosaic disease between sugar cane, maize, and certain grasses has been established by several workers, and has been confirmed by me under South African conditions. All attempts to secure infections of this new disease through the agency of *A. Maidis* have failed.

The experiments referred to have been carried out with leaf-hoppers collected in diseased maize fields. A proportion only of such individuals are capable of producing the disease, although the maize may be almost universally infected. No individuals, however, which have been once proved to be vectors, have failed to transmit the disease to all plants to which they have been subsequently moved.

Preliminary attempts to secure transmission of the disease from maize to sugar cane and grasses have not succeeded. It must, therefore, remain in doubt whether it is a single disease which occurs in the different hosts, although field observations and similarity of symptoms would point to this conclusion.

H. H. STOREY.

The Natal Herbarium,
Durban, July 8.

Isotopes of Mercury and Bismuth and the Satellites of their Spectral Lines.

IN his letter to NATURE (May 31, p. 781), Prof. Runge criticised the result of measurements on the satellites of mercury and bismuth lines in connexion with the isotopes, which I and my co-workers have communicated to NATURE (March 29, p. 459), as not convincing. It gives me much pleasure that our note has attracted the attention of such an eminent spectroscopist and mathematician as Prof. Runge. The aim of that note was to show that the wave-length differences $\delta\lambda$, according to our formula, which involves the masses of different isotopes, are found among the satellites of mercury and bismuth lines. Prof. Runge discarded i and j, and took wave-length differences of observed satellites at random, which is contrary to our view, as regards the selection. The example given by Prof. Runge seems to me to be *lauter Zahlenspielerei*.

Perhaps the lines we have cited have too many satellites to incur a criticism; there are, however, many lines with a small number of satellites, and in which the number of selections is but limited. I can cite many such examples, but as the result obtained on satellites of twenty principal lines of mercury has already appeared in the *Japanese Journal of Physics*, vol. ii., pp. 121-162, the publication of which was much retarded by the disastrous earthquake, I consider it needless to occupy the columns of NATURE with the details. We have obtained more than 130 coincidences with our formula, within the limits of errors of observation, in mercury lines from the yellow to the ultra-violet region, so that the probability of its validity is very great, and cannot be considered as due to mere chance The report on bismuth lines will shortly appear in the above Journal.

If we completely separate the isotopes, investigate the difference between the satellites and confirm our result, the proof will no more be open to criticism. Only partial separation of isotopes is at present possible, but even this will help us to study the intensity difference of the satellites, by which the present question can be in some degree settled more directly than by the arrangement of the satellites.

H. NAGAOKA.

Institute of Physical and Chemical Research,
Komagome, Tokyo, July 2.

The Cooling Power of the Air in Trains, Trams, and Buses.

By LEONARD HILL, F.R.S., with the co-operation of M. BRAD
(from the National Institute for Medical Research).

THE body resembles a motor-car engine in that it is producing heat by the combustion, not of petrol but of food, and, just as the car has a radiator, so has the body—namely, the skin—in order to lose heat and keep at body temperature, that is, the temperature at which the living tissues have to live. During muscular exercise, about four times as much heat is produced as work, and when hard exercise is taken, such as climbing, the heat production of the body may be five times as great as when sitting at rest. The loss of heat is controlled, just as the production, by bodily mechanisms. To accelerate heat loss, the skin flushes with blood and perspires; clothes are thrown off and the body fanned. Over-warm stagnant atmospheres and over-clothing check the production of body heat and lead to disinclination to exertion, loss of appetite, and, in time, to debility. Cool surroundings and light clothing, on the other hand, increase the production of body heat, tone up the body, stimulate appetite, impel to activity, and generally improve health.

The ordinary thermometer indicates the average effect of the temperature of the surroundings on itself. Unlike the body it does not produce heat. If a fan is set to blow about the air of the room in which it hangs, its reading does not alter. The body, on the other hand, is very effectually cooled by the fan. The thermometer is, then, an untrustworthy guide to ventilation. The kata-thermometer has been introduced to remedy its defects. This instrument has a bulb which is warmed to just above the average temperature of the human skin, and its rate of cooling is measured during a drop of five degrees, namely, between 100° and 95° F.

In this way the power of the air in any locality to cool a surface approximately at skin temperature can be measured. The measurements are made in millicalories per sq. cm. per second. The bulb of the instrument is roughly the size of the end joint of the thumb. The big masses of the body are cooled less rapidly, having a smaller surface in proportion to their bulk. The kata-thermometer does not, then, actually measure the cooling effect of the air on the human body, but is a valuable indicator of comfortable and healthy conditions.

In rooms kept fresh and warm enough for sedentary work, the cooling power is found to be about 6. In stuffy rooms 4, or even less; in rooms rather cold for comfort, 8. Out-of-doors, where the wind blows, cooling powers are higher; for example, 10 on a genial summer day, 20 on mild winter days, 40 on cold winter days. The open-air worker is stimulated by much higher cooling powers than the sedentary workers, even when the temperature is the same indoors and out, owing to the movement of the air out-of-doors.

As we have said, an adequate cooling power of the air is required to keep "the fire of life" from burning too feebly, to tone up the muscles, invigorate the nervous system, and make keen the appetite and efficient the digestion and action of the bowels.

It has been shown that exposure of the naked body of children to sun and open air, with of course wise prevention of over-cooling, has a wonderful curative effect on states of debility, rickets, and surgical tuberculosis. An adequate increase of cooling power puts up the basal metabolism, that is the heat production of the resting body, even 50–100 per cent. We know that thousands of clerks, shop assistants, factory hands taken from lives spent in monotonous over-warm places, were changed from feebly developed, nervous, dyspeptic men into strong healthy soldiers by training in open-air exercises during the Great War.

Severely exposed to weather in the trenches, these men suffered far less from catarrhal diseases than those who continued in employment in cities. The soldiers caught "colds" not in the trenches, but when on leave and infected by close contact with "carriers" in the crowded places of cities. Americans overheat their houses and suffer from catarrhal complaints. The death-rate from pneumonia in U.S.A. has not gone down with that progress in medicine which has notably lowered the death-rates from most other diseases. While exposure to the open air, with the invigorating effect of cool winds and daily exercise, is necessary for all who want to attain full health and enjoyment of life, people, mistakenly attributing the origin of catarrhal disease to exposure to cold, have in the past demanded the over-heating of railway carriages and shutting of windows and the closing in of the roof-seats of trams. Suggestions recently have been put forward for the heating of trams, and the roofing over of the outside seats of buses has been discussed. There have been many who have wished, and some more courageous, who have struggled to secure the opening of windows in trains, and these last have been ridiculed in the Press as "open-air fiends" by journalists who are habituated to the stuffy over-warm newspaper offices of Fleet Street. Soldiers, however, hardened in the trenches, on returning from the Great War demanded greater opening of windows in trains, and this habit of open windows has of late become more general.

People are beginning to realise that catarrhal infections are spread by wrong conditions of the atmosphere indoors, and by repeated massive doses of microbes inhaled from "carriers" who sneeze and cough in close crowded places. Even comic artists and artists of patent medicine advertisements now try to illustrate the happenings of such infection. As tube trains and trams are closed up more than buses, and as people continue to dispute over the opening of windows in steam trains, it seemed worth while measuring the cooling powers of the air by means of the kata-thermometer in such trains with windows shut or open, and in tube trains, trams, and buses, comparing in these last the inside and outside. The temperature of the air was also taken and the velocity of the air movement calculated from a formula which allows the kata-thermometer to be used as a very sensitive anemometer. The following are the average results of observations made when conditions were best in the non-crowded

parts of the day, in mild or cool weather, during September and October of 1923.

	Dry Kata-thermometer Cooling Power. Millicals per sq. cm per sec.	Temperature. °F.	Velocity of Air Movement. Feet per min.
Central London Tube.			
In moving train . .	6-10	70-72	54-222
Hampstead Tube.			
In moving train . .	5-9	66-75	55-270
On platforms . .	7-16	63-72	168-425
North London Electric.			
In moving train . .	4-8	60-75	12-83
Bakerloo.			
In moving train . .	5-6	73-75	49-59
S.R., L.N.E.R., and L.M.S.R.			
Steam Trains—			
In moving train :			
Windows closed .	5-9	52-70	20-35
Windows open and facing engine .	9-19	48-66	125-320
Windows open and back to engine	7-12	50-67	49-96
Trams, L.C.C.			
Moving	4-8	67-72	12-126
Buses.			
Moving, inside . .	9-20	57-61	71-541
„ outside . .	10-31	50-60	232-1043

The standard dry kata-thermometer cooling power suitable for sedentary work in ordinary clothing is 6. Lower cooling powers produce stuffy sensations and require less clothing. If people used foot-warmers, and in some cases wore more clothing when at sedentary work, they could easily bear windows open and a cooling power of 8, or even 10, and have the great advantage of breathing cooler, cleaner air. A sanatorium ward is best kept at such a cooling power as 10. In travelling to and fro wearing outdoor wraps, people can, with advantage, be stimulated by wind giving much higher cooling powers than 6. The bus stands pre-eminent in this respect, and healthy people who enjoy a blow in the fresh air and recognise the good effect of this on health rejoice in the open roof-seats of the bus. The cooling powers outside the bus were 10-31 against 4-8 in the tram. It is regrettable that the roof-seats of trams were ever closed. Those of buses certainly should not be. A removable rain screen open at the sides is all that is wanted in bad weather.

Tubes and steam trains with closed windows and trams are relatively stuffy places, cooling powers 4-10, compared to outside of buses, cooling powers 10-31, and steam trains with windows open, cooling powers 9-19. The seat facing the engine in the steam train with window open is recognised to be much cooler than that with the back to the engine; by how much on cool autumnal days the figures show, 7-12 against 9-19. The cooling power at a seat facing the engine can be doubled or even trebled by opening the window.

The figures also show that movement of air and not temperature is the chief factor at work.

In steam trains with windows open and on the outside of buses, massive infection with the microbes from "carriers" is impossible.

The British Association at Toronto.

(FROM OUR CORRESPONDENT.)

Toronto, August 10.

OPPRESSIVELY hot weather during the first half of this year's meeting of the British Association at the University of Toronto has made the excursions into the neighbouring countryside particularly popular among the 2600 men of science and citizens who have enrolled as members to the present date. Thunder showers at night have, however, cooled down the hot lecture rooms and rendezvous periodically, and have thus made meetings possible without interfering with communication in the daytime between the score of University buildings utilised for them. The overseas party, numbering 573, was fêted on the way through eastern cities, and most members of it have been given hospitality in private houses in Toronto. Others, with more than three hundred men of science from the United States, are quartered in University residences. Hart House, which is the social and recreational centre of the male University life, has been thrown open to men and women, and the dining-room has been extended to seat six hundred. The Toronto Board of Trade has been responsible for the enrolment of more than one thousand citizens, and the balance of local members is drawn from adjacent towns, many coming in every day for the meeting, so that the hotels are full.

The Convocation Hall of the University of Toronto, seating eighteen hundred people, was packed on Wednesday night, August 6, when Sir Ernest Rutherford vacated the president's chair for his successor, Sir David Bruce. While lightning flashed across black skies outside the building, Sir Robert Falconer, president of the University, welcomed the visitors and said that Canada needed the stimulus which this visit of the British Association would afford. Prof. J. C. Fields, president of the Royal Canadian Institute, also expressed the welcome of the hosts in the name of the Institute. Prof. J. C. McLennan, chairman of the general and executive committees, moved the vote of thanks to Sir David Bruce for his address.

Representative overseas delegates were received by Cabinet ministers in the Parliament Buildings on Wednesday afternoon, August 6, when the Hon. George H. Henry, senior Government minister, extended the hospitality of the Province to the Association. Sir Ernest Rutherford replied on behalf of the delegates. On the evening of August 7, a reception was given by the trustees and directors of the Royal Ontario Museum of Archeology, and was attended by two thousand people, including nearly all the members of the overseas party. The guests were received by Mr. J. B. O'Brian, the Hon. Charles McCrea, the Hon. Dr. Cody, and Mrs. Cody. Many social events have been held, including luncheons, teas, dinners, etc., arranged by

local societies and numerous private individuals. Saturday, August 9, was devoted to excursions, of which those to the Niagara Falls district were most popular.

The popular and citizens' lectures have been thronged. On Thursday, Sir Henry Fowler lectured on metallurgy and its influence on social life; on Friday, Mr. Julian Huxley on control of growth; and on Saturday, Prof. Eddington on relativity. The first children's lecture by Sir William Bragg, on Friday, was most enthusiastically received. Popular meetings and lectures are being broadcast and picked up all over America. The scientific sessions are attracting wide attention, Toronto newspapers devoting several pages to them daily, while the Canadian press generally is giving prominence to them, also the leading United States journals. The meeting is in every way a successful one, and the attendance is satisfactory. Prof. J. L. Myres, general secretary of the Association, praised the local arrangements when speaking at a dinner tendered to visiting Freemasons by the University Lodge on Saturday.

A party of geologists is making a tour in northern Ontario on August 14-19; one of botanists is visiting Temagami Lake district on August 14-18; and one of agriculturists is to visit the Ontario Agricultural College, Guelph, on August 15. Three hundred members are taking part in the general excursions to the Pacific coast, leaving on Sunday, August 17, arriving at Vancouver on August 25, and returning to Toronto on September 3. There will be meetings at Saskatoon, Edmonton, and Vancouver, and halts at all points of scientific or scenic interest. The party goes out by the Canadian National Railway and returns by the Canadian Pacific. Many visitors from Great Britain are making lecture tours in the United States before returning home.

Prof. Horace Lamb has been elected by the General Committee president of the Association for the meeting next year in Southampton.

At a special convocation of the University of Toronto on Wednesday night, August 13, the degree of Doctor of Science, *honoris causa*, is to be conferred on Sir David Bruce, Sir Ernest Rutherford, Sir John Russell, and Sir Charles Parsons.

The three remaining addresses of presidents of Sections were delivered on Monday, August 11, and are described below.

Analysis of Crystal Structure by X-rays.

In his address to Section A (Mathematics and Physics), the president, Sir William H. Bragg, gives a very useful summary of the present position and the limitations of the new methods of analysing crystal structure by means of X-rays. He first discriminates three distinct stages, namely, (1) the measurement of the angle at which X-rays of a given wave-length are reflected by a set of identically similar planes within the crystal; (2) the use of the angular measurement to find the spacing of the set of planes, and hence the linear dimensions of the crystal-unit cell; and (3) the combination of the spacings of three different sets of planes to afford the volume of the unit cell. From these fundamental determinations, and a knowledge of the specific gravity of the crystal, the number of atoms of various kinds contained in the cell are found; and, as the proportion of the various kinds is the same as in the molecule, the number of molecules, one, two, three, four, or rarely more, comprised in the cell is afforded. By the repetition of this cell, in accordance with the degree of symmetry developed, without any new features, the crystal is built up.

The final aim of the X-ray analysis is to determine the arrangement of the molecules, and of the atoms comprising the latter, in the crystal-unit cell. Sir William Bragg emphasises, however, that the only measurement which the X-rays make directly is that of the distance separating any atom in the crystal from any other nearest adjacent one which is of like kind and condition of environment, from which the outlook would be exactly the same and with similar orientation. Any other measurement of distance is an indirect one, made with the aid of some additional crystallographic (physical or chemical) reasoning. It is not possible to measure directly by X-rays the distance between two atom-centres within the same cell. For example, in the two-molecule crystal-unit of naphthalene we cannot measure the distance separating one carbon atom from another in the same dimolecular cell, even those of the two separate molecules (which are differently orientated); the measurements afforded are those between any atom and its nearest neighbours exactly like itself in the three principal (axial) directions; that is, belonging to different adjacent cells, these distances being the lengths of the edges of the unit cell. Fresh considerations, such as the knowledge that naphthalene has a centre of symmetry, are required even to define the distance between the centres of the two molecules in the cell; or as in the case of rock-salt, the knowledge of the full crystal symmetry is needed to give us the distance between adjacent sodium and chlorine atoms, the X-ray measurements only affording that between any two sodium atoms, or any two chlorine atoms. Hence, the work of the crystallographer is absolutely necessary, especially as to symmetry and the polarity due to lack of it, exterior angles and the crystal elements derived therefrom, and the physical properties, if the measurements by X-rays are to have their full value. It is a great gain that this has now been so clearly stated.

Sir William Bragg then shows how the X-ray work, combined with all these other available sources of information, is enabling us to fix on the particular one of the 230 modes of interior arrangement of atoms possible to crystals, which occurs in the crystal under investigation, and incidentally shows that all cases investigated have conformed to one or other of these modes. The lesser problem of allocating the crystal to its proper class among the 32 differently symmetrical classes of crystals has consequently been solved in most cases with comparative ease. But again, it must be emphasised that the X-ray measurements alone do not permit of so satisfactory a result being attained.

Sir William Bragg also makes it clear that the alarm exhibited, when the first X-ray results were published, as to the apparent disappearance of the molecule, was a "mare's nest." There is nothing whatever to suggest a complete disruption of the alliances within the molecule so successfully studied and brought to light by

the chemist, and it is now certain that the conclusions of chemistry are valid for and carried into the solid crystal as well as into the liquid, for the chemical molecule takes its place as such in the crystal structure with very little change.

It is thus in the combination of the results of the X-ray analyst with those of the crystallographer, the physicist, and the chemist that future progress in the elucidation of the structure of the fully developed solid—the crystal—must be looked for. In thus unambiguously setting forth the limitations of the new method by use of X-rays, and the absolute need of collaboration in the study of crystals and solids in general, the president of the Section has rendered a special service.

LIFE-CONTROL.

PROF. F. W. GAMBLE's presidential address in the Section of Zoology is an example of strong, matured thinking. It is futuristic rather than a retrospect of the things done and thought in the biology of the immediate past. Seizing on the present methods of experimental embryology it sees in them something pregnant with results that must profoundly modify future biological speculation. Can those results be seen, even if only in a vision, and what may be their nature? The address is an innovation that must be welcome to members of the Section.

More and more biology pries into the nature of the process that makes a specific organism from an apparently undifferentiated egg. This process, whatever it is, must be potential in the egg, becoming kinetic from the moment when the spermatozoon—the "Orpheus that visits the cold Eurydice," the "winged key that unlocks the imprisoned one"—passes through the bounding membrane and sets up the releasing transformation that results in embryonic development. The process is not in the outer environment which, while nurturing in precisely the same way the eggs of a hen and a duck, yet makes of the one a chick and of the other a duckling. Past conceptions of the nature of the developmental process were curiously naif; they conceived of the ovum about to divide as an assemblage of parts, jumbled together in some way, a chaos of parts but nevertheless parts that were preformed and extended. Something called the "organisation" was supposed to usher the parts into place, laying down, in ordered fashion, the organ-systems, organs and tissues of the embryonic body. Then came the study of aberrations of development to perplex and obscure this simple conception. The organisation existed in the undivided ovum, leading to the segmentation of the latter, so that a number of blastomeres came into existence, each normally giving rise to a different part of the embryonic (and so also the adult) body. Yet the experimentalist could literally shatter the organisation to bits and find that each bit became another organisation (for each blastomere could regenerate a whole embryo). He could divide it in an infinity of parts without impairing it. Thus the egg and its parts, or the embryo and its parts, were autonomous and capable of regulation. The study of the nature of the organisation became the study of life itself—and it became (to many minds) a problem incapable of solution on the classic physico-chemical hypothesis of the nineteenth century. To an increasing number of biologists life becomes an ultimate natural category sharing, with matter and energy, our conception of the universe.

Now among the pregnant methods of present-day embryology there is this: it has become possible to study the mode of operation of the organisation in the developing egg and in the adult, multicellular organism (and it is essentially the same in each of these cases). In the egg the organisation radiates from a focus: in the adult it radiates from an apex or head. The components of the radiation are from head to posterior body regions along the longitudinal nervous axis; from nervous axis to right and left in bilaterally symmetrical animals, and from nervous axis to the ventral regions (in vertebrates), or to posterior regions (in an insect). Along each of these radiative paths the intensity of the control exercised by the focal region diminishes with the distance; there are metabolic gradients and these are demonstrable by various chemical methods. The gradient expresses the degree of positive control which the head region holds upon the functioning of the bodily organs and tissues. This apical control is one of quickening, urging, and directing of physiological activities. The possibility of control is, so to speak, vested in the head, or apical region, which reaches out into the outer world by its distance receptors, ever seeking to increase its environment. Environment and organism, reciprocal activities, are one—that which we call ordered life.

Yet, because the intensity of quickening and directing diminishes with the distance from the focus, there can be physiological isolation of a bodily part—limited, of course, and it may be transient. In the absence of control the part rests—it may be periodically. While it rests its potential rises and when it again comes under the focal control its functioning quickens. So in reserve organic material, two kidneys or testes, one of which may be enough for normal bodily activity, there is periodic alternation of rest and activity. But in the rest consequent on the removal of control there is still the urge of life, for the potential of the part increases. Should the focal control not be re-established what happens? There is always the tendency to individualisation, and the organism may segment and multiply—thus in a dividing Planarian worm the metabolic gradient shows a peak at the region where segmentation will occur. So also we seem to be able to interpret the formation of malignant tissue. Removed from the control of the cerebrum, which blends the activity of the part with those of all other parts of the body the intensity of life may still increase during this resting phase. Then connective tissue, or mammary gland, or testis attains higher metabolic potential, and still drawing on the circulating nutritive materials it endeavours to function; it cannot do so in normal fashion because it is undirected, and it proceeds to proliferate, passing into the cancerous condition.

And here we see, stated as an inference from experimental results, something of the terribleness of life—that which is sinister because it is disorderly. There is a "submerged recessive life" charged with activity, ever seeking to expand or grow. Specific organisations deploy this in ordered morphological and functional varieties. Given this "grace of organic regulation" and the life that incessantly insinuates itself into inert

matter assumes the hierarchical forms that evolution shows us. Without it and we see in life something inchoate but, in a way, fœtid and malignant: something suggested to us by the cancerous tumour or the luxuriantly living and rotting tropical jungle. Here, and in the backwaters of organic evolution—the "living fossils" that are poised between extinction and stability, or the primitive and unprogressive human societies—we see the life of the future: the inextinguishable vital impulse that waits on the ordering control that will lead to its deployment in new organic forms.

PROBLEMS OF CROP PRODUCTION.

IN his address as president of Section M (Agriculture), Sir John Russell reviews the present position of agricultural research as compared with that occupied when the British Association visited Toronto in 1884. Up to that time the man of science had been occupied with the problem of how to feed the plant. Agricultural science was regarded as simply a branch of chemistry; but, during the last forty years, many new problems involving the biological sciences had presented themselves for solution. These problems are related to the growth of the plant as affected by inherent and environmental variations. Sir John Russell points out that, whereas the great discovery during the early period was that the plant could be fed by "artificial" substances, the most pregnant discovery of the second period was that the plant is plastic; by methods which are under scientific control it can be modified in desired directions, and thus be induced to give results that mere feeding cannot accomplish. Following the pioneer labours of Bateson, astonishing practical results have been reached by such workers as Biffen in England, Nielsen Ehle in Sweden, and the Howards in India. But the science of genetics is only on the threshold of what it may yet accomplish.

Sir John Russell then goes on to review, in detail, recent advances that have been made in the sciences with which he is particularly concerned at Rothamsted. He emphasises the pressing need for subjecting the great mass of material that has now accumulated to statistical analysis. In regard to the numerous empirical data from "field" experiments, Sir John Russell is of opinion that no advance can be expected until some fresh opening is discovered by scientific workers. With regard to the more rigid data accumulated by laboratory workers, the view is expressed that the greatest field for discovery lies in the direction of linking up plant nutrition studies with those of the soil solution, the latter being explored in the light of the physico-chemical interactions between soil and soil water. On the more general issues Sir John Russell is insistent on the need for fuller co-operation between all classes of scientific workers—for team work which shall include workers of all nations. But when all is said and done, the great expenditure of time and money now being incurred in agricultural research can only be justified by abandoning the view that the economic end alone is worthy of the effort. The address closes with an eloquent appeal for a wider vision, for an effort to upraise country life by revealing to the countryman "something of the wonder and mystery of the open spaces in which he dwells."

Obituary.

PROF. J. WERTHEIMER.

THE death, on August 9, of Prof. Julius Wertheimer, at sixty-four years of age, deprives both science and technical education of a most active and stimulating worker. Since 1890, when he was appointed principal of the Merchant Venturers' Technical College, Bristol, he took a leading part in promoting scientific and technological instruction in the city, with the result that, when the University of Bristol was established in 1909, the faculty of engineering was instituted at the College, with Prof. Wertheimer as dean of the faculty and also professor of applied chemistry.

Prof. Wertheimer was educated at University College, Liverpool, and Owens College, Manchester, and was headmaster of the Leeds School of Science and Technology from 1887 to 1890. He was a fellow of the Institute of Chemistry, the Chemical Societies of London and Berlin, and the Physical Society of London. He was for ten years hon. secretary of the Association of Technical Institutions, and was the author of text-books of practical chemistry and of scientific and educational articles in various journals, including NATURE. His long experience and wide knowledge of all matters relating to technological education at home and abroad made him a very valuable member of many committees. He served on the Council and Senate of the University of Bristol, the Teachers Registration Council, the Education Committees of the Gloucestershire County Council, the Bristol City Council, the British Science Guild, and other bodies. In recognition of his services to science and education the degree of doctor of science, *honoris causa*, was conferred upon Prof. Wertheimer by the University of Bristol in 1911. He also received the honour of Officier d'Académie de France in 1906.

MISS KATHERINE A. BURKE.

BY the death of Miss Katherine A. Burke, University College, London, has lost an excellent teacher who was untiring in her devotion to the academic, social, and athletic life of the college. Graduating at Birkbeck College, Miss Burke began her career at University College, in 1898, as a research assistant of the late Sir William Ramsay, and she took a share in the research emanating from the chemical laboratory at about this time. Later, she was appointed to the chemical staff, and was the first woman teacher directly concerned with the teaching of the undergraduates of the college. Miss Burke's original work included research on thorianite, the oxides of chlorine, the Joule-Thomson effect, the chemical dynamics of the alkyl iodides, and the absorption spectra of alcoholic solutions of nitrates. The paper on chemical dynamics, with Prof. F. G. Donnan (Journ. Chem. Soc., 1904, 555), showed that the order of reactivity of the alkyl iodides varied with the type of chemical reaction investigated, and hence it was not possible to ascribe their reactivity

to a uniform cause, such, for example, as a dissociation of the iodides into ions. A research, published jointly with Prof. E. C. C. Baly and Miss Effie G. Marsden (Journ. Chem. Soc., 1909, 1096), on the absorption spectra of the aqueous alcoholic solutions of nitric acid and lithium, ammonium, and silver nitrates in relation to the ionic theory, afforded strong support for the theory of hydrated ions. It was found that the limiting conductivity and the persistence of the absorption band of these solutions showed a minimum at three per cent. of water. During the War, in addition to her work in connexion with the Voluntary Aid Detachment, Miss Burke found time to assist in the preparation of synthetic drugs, which were so badly needed at that time.

Towards the end of her life, Miss Burke's activities were absorbed in the social and athletic life of the college, particularly in connexion with the acquisition and organisation of the sports ground for women students at Perivale.

WE regret to announce the death of Mr. Charles Leudesdorf, fellow and vice-regent of Pembroke College, Oxford, registrar of the University of Oxford, and author of a number of papers on mathematical subjects, on August 10, at seventy-one years of age.

Current Topics and Events.

THERE has been brought before the Council of the British Association at the Toronto meeting a special report by the Committee on Zoological Bibliography and Publication, dealing with the question of undue restriction in the distribution of H.M. Government publications. The results of the inquiries of this Committee are of general interest to scientific workers, and may be briefly stated. On applying to the heads of certain Government Institutions, the Committee was informed that no restriction had recently been placed on the distribution of publications of the Royal Botanic Gardens, Kew, the British Museum (Natural History), or H.M Geological Survey. On the other hand, it found that public libraries had suffered from a considerable cutting down of free or reasonably priced Parliamentary and Stationery Office publications (in respect of which some concession has since been made), that certain British scientific societies of standing are no longer able to obtain Government scientific publications in exchange for their own publications (though foreign scientific societies are not similarly handicapped); that free reprints to authors of papers published by the Government have almost disappeared; that there has been a cessation of the routine free distribution of agricultural leaflets; and that review copies of Government publications have been curtailed. These findings are in general agreement with the statements made in a leading article in NATURE, December 29, 1923 (vol. cxii. p. 925). The Committee considers that no loss would ensue were review copies to be furnished gratis to editors on application, and suggests that the Council of the British Association "might well represent to the Government that the publication of the results of research among people likely to appreciate them is no less important than the making of the researches themselves, and that to refuse the relatively small additional expenditure is materially to reduce the benefit of the original much greater expenditure." Bearing in mind the effective methods employed by other governments in the spread of their scientific achievements, no one is likely to quarrel with this exceedingly modest recommendation.

SCIENTIFIC men are indebted to Major A. G. Church for raising an important question in Parliament, namely, the assessment for income tax of professional men, more especially men of science, who are remunerated by a fixed salary and are therefore assessed under Schedule E. Professional men whose income is made up of fees, and who are, therefore, assessed under Schedule D, are allowed in the assessment of their incomes to deduct from their earnings expenses ordinarily incurred in the course of their work, including the cost of the renewal of technical works of reference, subscriptions to professional societies, the preparation and publication of memoirs —in fact, all expenditure required to maintain their technical efficiency. Such expenses are not as a rule allowed to those assessed under Schedule E. The Financial Secretary to the Treasury denied, however, the existence of such a distinction and offered to have any particular case investigated, in which further relief was believed to be due, provided the necessary particulars were furnished. The question was, as a matter of fact, brought before the Treasury two or three years ago, when it was intimated that such expenses might, for the purpose of assessment, be deducted from the salary received, when they were incurred in consequence of an express requirement of the employer. If, for example, on the appointment of a science lecturer it was stipulated he should carry out research, or that he should join the technical societies relevant to the subject he taught, or take other steps calculated to maintain his scientific position, the necessary expenses might be deducted in ascertaining his assessable income. It is for the colleges concerned to see that this requirement is satisfied.

THE Admiralty has announced the appointment of Capt. H. P. Douglas to the post of Hydrographer of the Navy in succession to Vice-Admiral F. C. Learmonth, as from October 1 next. Capt. Douglas has been employed in the surveying branch of the Navy since 1897, and held the appointment of superintendent of charts in the hydrographic department from 1910 to 1914. During the War, he was employed on special surveying staff duties at the Dardanelles and with the Dover Patrol, in addition to acting as the first director of the Navy Meteorological Service (1917). For his preparatory work in connexion with the raid on Zeebrugge he was awarded the C.M.G. He was assistant hydrographer of the Navy from 1919 to 1921, and has since been in command of H.M. Surveying Ship *Mutine*, and her successor,

H.M.S. *Ormonde*, on the Bermuda and West Atlantic Survey. He is the inventor of several instruments and diagrams for use in surveying and navigation. The post of Hydrographer of the Navy (instituted in 1795) was originally tenable at their lordships' pleasure, and for an unspecified term. Admiral Beaufort, still remembered in connexion with the "Beaufort scale" of wind velocities, occupied the position for twenty-six years (1829–1855), and the late Rear-Admiral Sir William Wharton for twenty (1884–1904). Since the latter's time, however, the tenure of the post has been limited to five years, its successive occupants having been Admiral Sir A. Mostyn Field (1904–1909), Admiral Sir H. E. Purey-Cust (1909–1914), Vice-Admiral Sir J. F. Parry (1914–1919), whose grandfather, Sir W. E. Parry, the celebrated Arctic explorer, was Hydrographer in 1823–1829 and the present Hydrographer, Vice-Admiral F. C. Learmonth, who, before taking up his appointment as Hydrographer, was Director of Fixed Defences from 1914 to 1919, and in that capacity won unstinted praise from Lord Jellicoe for his work in the production of net defences, both for the British fleet and for those of the allies.

THE Council of the National Institute of Agricultural Botany announces that it proposes to place upon the market this autumn about 2500 quarters of a new seed wheat, Yeoman II., bred by Prof. R. H. Biffen; and tenders as to quantity are invited from established dealers in seed corn. The seed wheat will be sent out in sacks closed with the Institute's seal, none other being genuine, at the rate of 6*l*. 6*s*. per 4½ cwt. Yeoman II. is intended to take the place of the older Yeoman wheat, partly because pure seed of the latter is now difficult to obtain owing to admixture with other wheat, partly because Yeoman II. is a better wheat in several respects. Both wheats are products of the same cross, Browick × Red Fife, and are similar in type. The yielding capacity of Yeoman II. has been tested out at ten different centres on varying soils throughout the country, with thoroughly satisfactory results. Comprehensive milling and baking trials made by impartial judges of the National Association of British and Irish Millers indicate that the bread made from the flour of Yeoman II. is of exceptionally good quality and is "incomparably superior to anything obtainable from average ordinary English wheat" In favourable seasons the loaves approximate closely to those from "No. 1 Manitoba" wheat. It is strongly advocated that from the different points of view of growers, millers, and consumers, Yeoman II. should take the place of the older form. It is particularly suitable for growing on medium and heavy soils which are in good heart, and is specially recommended for the eastern, midland, and southern counties of England, the best results being obtained with early sowing.

A TALK on "Life of the Sea-shore," by Mr. T. Howard Rogers, broadcast from the Birmingham Station of the British Broadcasting Co. on July 29, was the first of a series which will be continued until the end of the year by members of the Birmingham Natural History and Philosophical Society. On August 9, Mr. O. T. Elliott dealt with "Germs—Beneficial and Otherwise," and the second and concluding part of his lecture will be given on August 16. Other talks which have been arranged are: "Butterflies," by Mr. J. H. Grant (Sept. 9); "The Earliest Known Life of the Earth," by Mr. Frank Raw (Sept. 17); "Flies," by Mr. Colbran J. Wainwright (Sept. 23); "Fossils," by Dr. L. J. Wills (Oct. 7); "How we get our Time," and "The Moon," by the Rev. E. S. Phillips (Oct. 14), "Plant-animals," by Dr. W. T. Elliott (Oct 21); "Fairy Rings," by Dr. Jessie S. Bayliss Elliott (Oct. 28); "Algeria," by Capt. C. K. Shepherd (Nov. 4); "Shells," by Mr. H. Overton (Nov. 11); "Life of the Ocean," by Mr. T. Howard Rogers (Nov. 18); "Saturn," by Mr. S. C. Parish (Nov. 25); "Aquaria," by Mr. G. T. Calvert (Dec. 2); "The Modern School-boy," by Mr. F. W. Pilditch (Dec. 9); and "The Life-story of the Eel," by Dr. A. J. Grove (Dec. 30). The subjects are being dealt with in an interesting and non-technical manner; and it is hoped that these instructive talks, which are addressed primarily to young people, will arouse interest in, and foster a taste for, natural history and kindred scientific subjects, and prove a helpful contribution to the valuable educational side of the programmes broadcast by the B.B.C.

IN connexion with the Exhibit in Gallery II. of the Government Pavilion at Wembley, by the Cambridge School of Agriculture, illustrating fertility and sterility in domestic animals, an excellent explanatory memorandum by Mr. J. Hammond has been issued by the Ministry of Agriculture and Fisheries. Sterility in the male is illustrated by microscopic preparations showing the semen of a sterile bull devoid of spermatozoa owing to the atrophy of the seminiferous cells—a condition which may follow inbreeding and other types of mismanagement. The reproductive process in the female is illustrated by a preparation of the reproductive organs of the cow, and the memorandum gives a short but clear summary of what is known of the physiology of these organs. Incidentally, mention is made of the striking demonstration of the control exercised by the corpus luteum over the ripening of the next Graafian follicle, that is obtained by expelling the corpus luteum from the ovary by simple pressure through the rectal wall, the result of this operative procedure being to bring on the next heat period before the time at which it would normally occur. Various causes of sterility in the cow are dealt with in the memorandum. The exhibit dealing with the sow illustrates the curious secondary limitation of fertility which occurs in this animal through degeneration and elimination of some of the embryos during the period of pregnancy, the potential brood of about 20 being reduced in this way to an average of about 8 or 9. In the rabbit such absorption of fœtuses is produced experimentally by removal of corpora lutea during early pregnancy, but in this case all the fœtuses disappear instead of only some of them as is the case in the sow. A similar result is seen in a rabbit which mates while still suckling a large litter, very active lactation having itself an

atrophic influence on the corpora lutea: in this case the effect may be prevented either by reducing the number in the litter to one or two, or by special feeding. The exhibit is one of much interest, and it will serve a good purpose by directing attention to the enlightened policy adopted by the Government of recent years, of encouraging research in external institutions such as Universities and independent laboratories.

Mitteilungen, No. 6, for June 1924, of the Society of German Men of Science and Physicians, are largely occupied by a discussion of the participation of Germany in international congresses. Léon Bourgeois is quoted as having said in 1913: "Coordonnons nos recherches, unissons et centralisons nos efforts, ne nous laissons distraire ni diviser par rien . . ." That was in the earlier days of tuberculosis inquiry, to which Koch, Ehrlich, and Behring have since contributed. Fritz Haber has spoken explicitly as president of the German Chemical Society meeting on May 12. He notes a mellowing of relations and a wish for closer scientific intercourse, expressed in particular by the United States, England, Russia, and Japan, as, for example, the invitations of the British Chemical Manufacturers and of the World Power Conference. The facts are given in greater detail in a paper on "International Scientific and Technical Congresses," pp. 53 to 67 of *Mitteilungen des Verbandes der Deutschen Hochschulen*, May 1924. The editor invites further reports directed to Johannisstr. 7, Munster in Westphalia. A list of 84 congresses is reviewed. Germans have joined in discussing physiology at Edinburgh, psychology at Oxford, orthopedics at Amsterdam, plant diseases at Wagening, serum at Copenhagen, pedagogy at Montreux, international law at Brussels, psychic sciences at Warsaw, dentistry in Paris, meteorology at Utrecht, gardening at Amsterdam, sociology in Rome, milk at Washington, philosophy in Naples, applied mechanics in Delft. Co-operation is absolutely necessary for the future of science, but much patience is required, for pressure in any direction might hinder more than help. The fullest list of international societies of all sorts is the "Répertoire des Organisations Internationales," published in Geneva for the Société des Nations. The director, Section of International Bureaux, League of Nations Secretariat, asks for information as to new societies or changes in older ones.

PROF. DR. RICHARD ZSIGMONDY, of Göttingen, has been elected a corresponding member of the Vienna Academy of Sciences.

A PROFESSOR of science is required at the Royal Military Academy, Woolwich, particulars of which can be obtained by written application from the Under Secretary of State, War Office (S.D.3), Whitehall, S.W.1. The completed form must be returned by August 21.

THE Department of Scientific and Industrial Research invites applications for the post of superintendent of its Chemical Research Laboratory. Candidates should have had experience of, and be distinguished in, some branch of pure or applied chemistry. Particulars of the duties of the post and a form of application are obtainable from the secretary of the department, 16 Old Queen Street, S.W.1. The latest date for the receipt of applications is September 30.

A SHORT time ago the question was raised in NATURE as to the possibility of registering priority in scientific discovery, on the analogy of a patent registering priority in invention. The device of sending in contributions under seal need not be forgotten. Even if afterwards published in some more finished form, the sealed documents should afford proof of the stage already reached at the date when they were handed in. The Academy of Sciences in Vienna reports the receipt of papers on the reproduction of lantern slides by an electrical method, on the action of Röntgen rays on organism, and a new treatment of carcinoma, a proof that the equation $x^n+y^n=z^n$ has no solution in rational numbers when n is greater than 2, and several other matters.

WE have received from the Russian Academy of Science of Leningrad the June issue of *Electritchestvo*. In honour of the centenary of Lord Kelvin it is called the "Lord Kelvin Number," and is devoted to articles in appreciation of his various activities by eminent men of science and engineers. The address presented at the Commemoration Celebration in London is quoted. "All Russian scientific men and engineers send their greetings to the Mother Country" of Lord Kelvin. "May the same spirit of sincere fellowship, which unites to-day the scientific workers of the whole world, form closer bonds between them for the benefit of humanity." Prof. Steklov, the vice-president of the Russian Academy of Science, writes an appreciation of the wonderful creative genius of Kelvin and his constant searchings after new physical laws. He, more than any one, tightened the bonds between pure science and engineering. Prof. Ossadchy, vice-president of the Gosplan, gives a résumé of Kelvin's work on telecommunication, and points out how its development was strongly influenced by his ideas. Prof. Châtelain, the president of the Russian Section of the International Electrotechnical Commission, discusses Lord Kelvin's work in the domain of electrical engineering. Its exceptional value lies in the fact that Kelvin laid sure foundations on which later workers have built a noble superstructure.

MESSRS. W. HEFFER AND SONS, LTD., Cambridge, announce for publication in the autumn a translation, by T. R. Parsons, of "Practical Physical and Colloid Chemistry for Students of Biology and Medicine," by Prof. L. Michaelis, of Berlin, which work was written to meet the needs of biologists and physicians desirous of becoming acquainted with the more important applications of physical and colloid chemistry to the problems of life and disease.

In order to show French textile manufacturers that it is no longer necessary to purchase their machinery outside France, M. A. Renouard has an article of 69 pages in the May Bulletin of the Société d'Encouragement. It is well illustrated and shows that, since the War, French textile machinists have introduced improvements into spinning frames, looms, and other machines which place them in the front rank.

The Department of Mines of the Queensland Geological Survey is issuing a series of reprints dealing with Industrial Minerals, giving a brief summary of the occurrences, treatment, uses, values, and production of these minerals, with special reference to Queensland resources. Nine of these pamphlets have been issued dealing respectively with salt, asbestos, mica, molybdenite, platinum, nickel, graphite, manganese, and arsenic.

In the Annual Report of the Raffles Museum and Library, Singapore, for the year 1922, Major J. C. Moulton gives a list of 44 specialists whom he has induced to assist in naming the collections of the museum. Progress has been chiefly marked in the insect collections, and many papers describing new species contained in them have been published. "As a result the museum is becoming more widely known as a *live* institution, and an increasing number of inquiries have been received from many distant parts of the world concerning the fauna of Malaya." It is to be hoped that this good work will continue in spite of Major Moulton's transference to a higher post.

Report No. 27 of the Industrial Fatigue Research Board records the results of investigations into the following industries: the textile, metal, boot and shoe, pottery, glass, and laundry, and into some repetition processes. It is thus a compilation by means of which the findings of different investigators in different industries can be conveniently compared. The various recommendations have been grouped under the following headings: (*a*) working conditions, (*b*) working methods, (*c*) administrative. It is only by the slow accumulation of data from many fields that generalisation of scientific value can be made. We are yet far from generalisation, but these studies show the direction in which available evidence points and suggest further developments.

Our Astronomical Column.

The Opposition of Mars.—At midnight on August 22-23, Mars will be nearer the earth than it has been for more than a century. The conditions are, in fact, the best possible for a close approach. These conditions are attained when opposition occurs a week before Mars passes perihelion, from the fact that the earth is then nearer to its aphelion.

At these close oppositions, Mars considerably outshines Jupiter, and its ruddy light renders it a very striking object. It is 10° further north than in June 1922, so that the conditions for observation in England are not quite so hopeless as they were then. Unfortunately, these very near oppositions have seldom been so fruitful in telescopic discoveries as those occurring somewhat later in the year. Thus Schiaparelli's work on the canals was mainly done in 1879 and 1881, though he was observing in 1877. The late Prof. Lowell, whose long-continued scrutiny of the planet under all possible conditions adds weight to his opinion, explained this by August oppositions occurring at the dead season of canal development, when the supply of moisture from one polar region had exhausted itself, and that from the other had not commenced. It is interesting to learn that his widow is visiting Flagstaff; her presence will doubtless encourage the observatory staff to make the most of their splendid equipment. The 24-inch Alvan Clark refractor, and the seeing conditions at a height of 7000 feet in the Arizona desert, are universally admitted to be unrivalled. Prof. W. H. Pickering is remaining at Mandeville, Jamaica, until after the opposition.

Sun-spot Activity.—A noticeable feature on the sun's surface since August 1 has been a well-defined circular spot, in latitude 6° north, which passed through the centre of the disc between August 6 and 7 The history of this spot has been followed on the Greenwich photographs since July 9, when a large bi-polar group commenced to develop in a small area of faculæ seen at the east limb of the sun on July 6. The total area of the group reached 1/2000 of the sun's visible hemisphere about July 13, after which the rear components disappeared, leaving the leader to continue uninterruptedly in the following rotation. No pronounced magnetic disturbance occurred at Greenwich when the spot was near the sun's central meridian.

The period embracing a solar minimum is well known as one of transition; the passing cycle is represented by sporadic spots near the equator, whilst the spots of the coming cycle are appearing in higher latitudes (20°-35°). The last solar minimum is now definitely concluded, and although small equatorial spots might have been expected, a spot group of this extent and length of life is remarkable. It will afford additional data for determinations of magnetic polarities at Mt. Wilson, which are of added interest at this phase of the solar cycle in view of the observed reversal of polarities.

Two Notable Variable Stars.—The June Monthly Notices of the Royal Astronomical Society contain papers on the well-known variables Mira Ceti and β Lyræ.

The former is discussed by Dr. W. J. S. Lockyer, the star having been observed both for magnitude and spectrum at the Norman Lockyer Observatory, Sidmouth, last winter. The maximum was attained on January 29, in accord with Leon Campbell's prediction; the star was unusually faint, only rising to 4·9 mag., whereas it attained 2·2 mag. in 1906; it seems to have been the faintest maximum since 1886. The bright hydrogen lines were also feebler than usual; a discussion is given of their relative brightness. The more prominent dark lines were also studied, and indicated the presence of calcium, manganese, iron, aluminium, strontium, chromium, titanium. It was noted that there were several instances of the intervals between absorption lines having previously been mistaken for bright lines, and that apparently the only bright lines present are those of hydrogen.

Miss M. A. Blagg contributes a long paper on Baxendell's observations of β Lyræ, which ranged from 1840 to 1877. She concludes that the period is increasing, and gives the following formula for principal minimum: Julian Day $2398590{\cdot}57 + 12{\cdot}908\ E + {\cdot}0000037\ E^2$. She also finds a subsidiary variation with a period of 6·576 days; the fact of its being so nearly half the principal period increased the difficulty of analysis.

Research Items.

AN AMERIND TYPE FROM CHINA.—Prof. Seligman figures in *Man* for August two examples of Chinese art of the T'ang period which provide a striking corroboration of the view put forward by Dr. Hrdlička on several occasions, notably at the Nineteenth International Congress of Americanists (*vide* Proceedings XIX. Int. Congress Americanists, p. 565), that a type identical with, or close to, the American Indian occurs over a wide area in Eastern Asia. The first of these is a whistle, roughly spherical in form, of a well-baked whitish paste, representing a head, of which the face and scalp are covered with a dull light green glaze. This might perhaps have been regarded as a freak, had it not been for a second and more striking specimen in the Eumorfopoulos collection. This is a small figurine of much the same quality as the whistle, and also covered with green glaze. In both cases the features are distinctly Amerind in cast, while the treatment of the hair suggests the lank locks of the characteristic American Indian type.

MOLLUSCAN PROBLEMS.—The crystalline style of molluscs has always puzzled biologists, and even now there is no clear indication of its full functions. Robson performed a useful service in collecting together all records of its occurrence not only in Lamellibranchs but also in Gastropods, and any comprehensive view of its function must apply to both these groups. Many writers have shown recently that the style contains an amylolytic ferment in certain forms, but other equally good workers have not been able to find significant quantities of ferment in the style of other species. There is therefore room for a comprehensive piece of work on this aspect of the question, since generalisations from results of experiments on a few animals are not yet valid. Huxley suggested long ago that the style probably revolved in the stomach, and Nelson has seen the revolutions in a few bivalves, but more observations are again needed, as also of the use of the style to draw into the stomach the food-entangling mucus-strings as described by Orton and Worsnop in the oyster. The ready solution of this organ in unfavourable conditions in some forms and its high resistance to solution in others indicates that the style may have somewhat different functions even in closely related animals. We shall therefore not be in a position to dogmatise on the function of the style in molluscs until a great deal more information has been collected. Another old molluscan problem, which was regarded as of great moment at one time, namely, the question of the possibility of the intake of sea-water, has apparently been settled. Pelseneer long ago acknowledged the occurrence of a water system in the foot of Naticidæ, but completely separated from the circulatory system and used for distending the foot in burrowing, and similar cases have been recorded by Lewis and by Mitra, who was also one of the first workers to demonstrate the existence of a ferment in the crystalline style. But no case of direct communication between the blood system and the exterior has yet been demonstrated, and seems unlikely to occur. There still remains, however, the problem of the possible absorption of water into the system, either over the whole exposed surface or portions of the surface of the body of a mollusc.

THE TWINNING AND MONEMBRYONIC DEVELOPMENT OF PLATYGASTER.—Messrs. R. W. Leiby and C. C. Hill contribute an interesting account (*Journ. Agr. Res.*, Washington, vol. 25, No. 8, 1923) of the development of *Platygaster hiemalis*, a hymenopterous parasite of the Hessian fly. The female deposits a group of four to eight eggs in the egg or in the young larva of the host. During maturation two polar bodies are formed in the egg, and these unite to form a single polar nucleus in the anterior region of the egg. Maturation is stated to be identical in fertilised and in unfertilised eggs. After maturation the male and female pronuclei fuse to form the cleavage nucleus, which lies in the posterior part of the egg. In the unfertilised egg the female pronucleus is found in a corresponding position. The portion of the egg containing the cleavage nucleus becomes differentiated and forms the embryonic region; the remainder of the egg containing the polar nucleus is homologous with the trophamnion and paranucleus of previously described polyembryonic insects—its function is to nourish the embryos until they are young larvæ, and can feed for themselves upon the host. The embryonic nucleus and the polar nucleus each undergo division into two and then four. The embryonic region in some of the eggs then divides to form two embryonic regions which become separated from each other—each carrying with it two of the four paranuclear masses. This separation results in the production of twin germs, each of which develops into a larva. The embryonic region of other eggs does not separate into two, and such eggs produce a single larva. The twinning development, here described for the first time, illustrates a simple type of polyembryony.

RAINFALL IN AUSTRALIA.—The rain map of Australia for 1923 compiled by the Commonwealth Meteorologist shows the distribution of rain for the year and for each separate month. There are also a number of charts showing the areas with rainfall above the average in recent years. The chief maps are based on the records of some 1300 well-distributed stations. About 22 per cent. of the continent had a rainfall above the normal, but the excess was mainly in the west, south-east, and Tasmania, while in 1922, when the area of excess reached about the same percentage, it was mainly in the north. In Queensland and parts of northern New South Wales, the dry conditions which had prevailed in 1922 continued and intensified into conditions of severe drought. It was only in June and December that the rainfall was at all satisfactory. In south-eastern Australia the fall was poor during the first half of the year. Conditions during the cereal-growing period were very favourable throughout most of the wheat region, but in northern New South Wales and Queensland crops failed on account of the drought.

OPALESCENCE AT AND NEAR THE CRITICAL POINT.—M. A. Audaut, in the May-June number of the *Annales de Physique*, describes a very comprehensive investigation of this phenomenon for five liquids with high critical temperatures. He measured both the diminution of the intensity of the transmitted light, and the intensity of the light scattered at right angles to the line of incidence, and found that the critical opalescence has the same intensity for a given substance when the experimental conditions are the same, and is not due to dust or impurities. Slow change of temperature and thorough stirring are necessary to obtain well-defined opalescence, a rate of one degree change per hour having been adopted. The opalescence was found to be a function of the temperature, of the wave-length of the light employed, of the amount of substance in the tube, the "filling," and

of the nature of the substance. The appearances observed at different temperatures and with different fillings agree with the theory of Einstein and Smoluchowski, which explains the opalescence as due to molecular agitation, using the analogy of Brownian movements. There is a critical filling, with maximum opalescence, which in this case is found at the same temperature with rising and with falling temperature; this temperature coincides with the critical temperature, which can be determined with accuracy by measurements with different fillings The method gives for ether and ethyl acetate 193·3° and 249·8° for the critical temperatures, and 0·259 and 0·306 for the critical densities. The number, N, of the molecular aggregates concerned per c.c. can be deduced by means of the theory from the observations of the opalescence; for ether, at 2·5° above its critical temperature, two values were obtained for N: 62×10^{22} and 58×10^{22}.

ADSORPTION AND CATAPHORESIS.—In the *Comptes rendus* of the Paris Acad. Sci., June 23, M. K. v. d. Grinten describes observations made with the ultramicroscope on a suspension of fine particles of the same glass as that employed in the construction of the trough containing it. Platinum electrodes 40 cm. apart were placed in the trough, and the potential difference between them was 10 volts. The velocity of the particles near the glass walls was in the opposite direction to that of those midway between them; the velocity of the latter, near the positive pole, was double that along the wall near the negative pole. When the thickness of the trough is more than 0·5 mm. the velocity of the particles in the middle region no longer varies with the thickness. This indicates that the liquid in the middle region remains at rest and the measured velocity is the true velocity of the particles with respect to the liquid. If electrolytes are added the cations of which are adsorbed, the velocity of the particles diminishes, and reverses for a certain concentration of the electrolyte. Methyl violet (*violet crystallisé*) was used as the added electrolyte, and the maximum number of molecules adsorbed per sq. cm. of glass sheet was found to be $1{\cdot}6 \times 10^{14}$. At small concentrations the adsorption grows rapidly with the concentration, but from the concentration $n/10000$ on it grows less rapidly towards the maximum, when it is concluded that a monomolecular layer is formed over the whole surface of the glass. The curve showing the relation of the cataphoresis velocity to the concentration, and that showing the relation of the number of adsorbed molecules per sq. cm. to the concentration, have the same form; starting from concentration $n/10000$, the two curves rise almost perpendicularly to the X axis. Similar results were obtained with suspensions of selenium. It appears then that each particle in the suspension is covered with a monomolecular layer when a certain concentration is reached.

WHAT IS MATTER?—In the issues of *Die Naturwissenschaften* for July 11, 18, and 25, Prof. H. Wehl, of Zurich, passes in review the various answers which have been given to this question. Of these the older "substance theory" has played its part and disappeared, leaving the "field theories" of Mie and others and the "dynamical theories" in possession of the stage. Some form of dynamical theory gives, according to Wehl, the greatest insight into the question, and he outlines his own view as follows: Matter is an agency which generates a field, the field a medium which propagates the action of one body on another. An "active mass" m generates about itself a field $m/4\pi r^2$ and a "passive mass" m' placed in this field is acted on by force $mm'/4\pi r^2$. By a proper choice of units the passive and active masses of a body may be made identical, and the conception of the field as a flux from the active mass gives the inertia of the mass as due to the field it generates about itself.

DEVELOPMENT OF PHOTOGRAPHIC LENSES.—Those who are interested in the history of the development of lenses for photography will find in the August number of the Royal Photographic Society's Journal an exceptionally valuable contribution by Prof. Moritz von Rohr. Since the publication of his "Theory and History of the Photographic Objective" in 1899, he has found many new facts, and it is these that he here records. He refers to work by C. Scheiner in 1618, J. G. Leutmann in 1719, Thomas Young in 1800, Coddington, Airy, and others, in the prephotographic period. Then follow accounts of A. S. Wolcott's pioneer work in 1843 (who appears to have been the first to produce a symmetrical doublet and a revolving diaphragm), a symmetrical doublet with plane cemented surfaces by H. Fitz, and the efforts of American opticians (1860–66) in the production of wide angle lenses. The great theoretical importance as well as the practical efficiency of the negative lens used by Piazzi Smyth to flatten the field of the portrait lens in his small camera that took plates one inch square is discussed. The author has obtained from Mr. J. Stuart two letters written by Monckhoven (1865–67) recommending Thomas Ross to take up the manufacture of H. A. Steinheil's *f*/8 aplanats. A full translation of these letters is given, and the originals were presented to the Royal Photographic Society. The paper concludes with a long list of references to the sources of information.

CHEMISTRY OF INSULIN.—*Chemistry and Industry* of July 18 contains an account of a paper by Mr. F. H. Carr, of British Drug Houses, on the manufacture of insulin. An account of what is known of the chemistry of insulin, the most important property of which is its action in causing the disappearance of glucose from diabetic blood, at the rate of 3 grams of sugar per 0·0001 gram of insulin in two hours, is first given. Insulin appears to be sparingly soluble in water at its isoelectric point of $P_H = 5{\cdot}2$, but readily soluble at other points near neutrality, precipitated by half saturation with ammonium sulphate and sodium chloride and other reagents, insoluble in absolute alcohol, free from phosphorus, tryptophane, and tyrosine when pure, but containing organic sulphur. Insulin from ox-pancreas gives the biuret reaction, but that from skate-pancreas does not. It does not pass a collodion ultrafilter and is destroyed by pepsin and trypsin, and therefore appears to be of protein-like structure. Insulin is extracted from animal pancreas, which is the part of the body in which it is mainly stored, and recent experiments show that it is present in a more easily separable form in many fishes near the gall bladder. The method of manufacture is rather complicated, but depends essentially on extracting the disintegrated pancreas, rendered acid to P_H 2·5 or alkaline to P_H 7·0, with 65-70 per cent. alcohol, in which little enzyme is dissolved, cooling to $-5°$, filtering or centrifuging, concentrating at low temperature to one-tenth the volume, extracting the fat, precipitating the proteins with absolute alcohol or ammonium sulphate at P_H 5 and further separation of the separated proteins with alcohol and picric acid. The large scale operation is continuous, and a flow sheet is given. As a result of improvements, the selling price of insulin has been reduced from 25*s*. to 2*s*. 8*d*. for ten doses. The really wonderful results of insulin treatment in advanced cases of diabetes are set out.

The Fourth International Congress of Refrigeration.

THE fourth International Congress of Refrigeration was held in London in June last. The Congress was organised by a committee of the British Cold Storage and Ice Association, working in conjunction with the Institut International du Froid. This International Institute is an organisation in which each State, Dominion, or Colony, signatory to the International Convention, is represented by delegates appointed by the participant State in a number proportioned in accordance with the amount of annual subsidy, varying from 1000 to 12,000 francs. It is interesting to note that forty-eight countries have signed the International Convention.

The Institute devotes its energies to further the science of refrigeration; to encourage the study of the best solutions of questions relating to the conservation, the transit, and the distribution of perishable produce; to the publication of all information relating to the world's frozen-food situation.

The study of the above-mentioned subjects is pursued by sixteen separate commissions. The function of the International Congresses is to coordinate and afford a common meeting ground for the members of these commissions and to all interested in refrigeration.

The work of the London Congress was subdivided between seven sections dealing respectively with: 1. Scientific Questions—Physics, Units, and Biology. 2. Refrigerating Materials—Machines, Insulating Materials and Testing. 3. General Applications of Refrigeration—Food, Agriculture, Ice, etc. 4. Refrigerated Transport—Railway and Steamship. 5. Legislation. 6. Education and Propaganda. 7. General Economics and Statistics. Thus one section would embrace the subjects coming within the purview of a number of separate commissions.

The meetings of the Congress were well attended by those engaged in the practical side of refrigeration. The title "Congress of Refrigeration" failed to attract many physicists, although Section 1 had on its programme a fine series of papers from the Leyden Cryogenic Laboratory.

The character of the papers will be realised from the following titles selected at random: "Organisation of the Work of Commission No. 1" (Kamerlingh Onnes). "Report on the Freezing Point Temperatures of Organic Substances suitable for Use as Reference Points for the Low Temperature Scale" (Jean Timmermans). "The Isotherms of Hydrogen, from $-217°$ C. to $-240°$ C." (J. C. Swallow). "Report on the X-ray Investigation of the Constitution in the Liquid and Solid States of Substances at Low Temperatures" (W. H. Keesom). "Low Temperature Investigations in the Service of Cosmical Physics" (L. Vegard).

The papers of a biological character submitted to Section 1 were rather disappointing, and it was evident that the majority of the contributors did not regard the Congress as the place to discuss purely scientific matters. It is a pity that this outlook should prevail, for it is obvious that an international congress which gathers under one roof the diverse interests concerned can exert an enormous influence on the progress of refrigeration on both the theoretical and the practical sides. Hence, on the purely biological side of the science of refrigeration there is but little which calls for comment, so far as the present Congress is concerned.

Some of the most interesting of the papers on the practical side were those dealing with the transport of refrigerated produce by land and sea and those on special applications of refrigeration. Of the papers dealing with the marine side, one might be mentioned —"Special Methods of Construction of Ships and Refrigerating Appliances for Vessels employed on Long Voyages" (A. R. T. Woods).

As regards land transport, the paper on "The Influence of Refrigeration in the Preservation of Fruit with Special Reference to South African Export Varieties" (I. B. Pole-Evans and Edgar A. Griffiths) is noteworthy, as it records the results of experiments on special trucks carrying fruit a distance of 1000 miles through semi-tropical heat.

The paper on "Temperature and Metabolic Balance in Living Plant Tissues" (F. Kidd and C. West) is a useful sketch of some recent work in America and Germany.

The work of the Insulation Sub-Committee of the Food Investigation Board was summarised in a paper of about eighty pages with the title "The Scientific Study of Heating Insulating Materials" (Sir Richard Glazebrook and E. Griffiths).

An interesting contribution on one of the special applications of refrigeration was that on "The Application of Refrigeration to the Ventilation of Mines" (F. A. Willcox and J. D. Farmer).

Mr. W. B. Hardy, director of the Food Investigation Board, gave an admirable sketch of what he considered to be the correct function of the Food Investigation Board and the work of a research station. He pointed out that of the problems which an industry presents, some are fundamental and far-reaching, others special and local. He quoted two examples to illustrate what the Board conceived to be their special province of work. One was the problem of the freezing of beef and most white fish. Can these materials be so frozen as to recover their original state on thawing? When beef is thawed after being frozen, its texture is impaired, and it drips a fluid rich in dissolved nutritive material. This is due to that separation of water from other constituents which is a common feature in the freezing of solutions. Is it possible so to modify the whole cycle of physical events compressed in freezing and thawing as to bring this separation of water under such control as will lie within the four corners of a possible commercial process? No answer is yet forthcoming, because the theory of the freezing of tissues is yet in its infancy. Animal tissues are colloidal structures, and of the effects of low temperatures on colloids little is known. This is a fundamental problem because its solution involves the whole theory of the freezing of tissues. If and when it is solved, and it may be years before that difficult end is attained, any feat of freezing should be possible, or, to be more exact, the possibilities and impossibilities of freezing as a mode of preserving animal or plant tissues should be capable of fairly exact delimitation.

The other problem put forward by Mr. Hardy was purely physical. The Board were consulted as to the following:

A certain store was cooled by a fan driving air over calcium chloride brine, the cold air being then supposed to circulate throughout the chamber. Meat stored there became discoloured and unpleasant to sight and touch. This was ascribed to putrefactive organisms—to bacteria, in short. The solution of the problem proved simple. Bacteria as the *causa vera* were readily ruled out. The wind from the fan produced an invisibly fine spray of brine which settled on the surface of the carcases, where the calcium chloride reacted with the red colouring matter hæmoglobin to produce methæmoglobin. The scientific interest up to this point is small, and the problem,

though of some practical interest, does not rise above the level of the ordinary works laboratory. A study of the air currents in the chamber, however, revealed the fact that the fan, though seemingly placed where it would circulate the whole body of enclosed air, did as a matter of fact merely puddle in its own neighbourhood, producing powerful vortices on the surface of the brine. This and many similar instances have convinced the Board that the principles which underlie the movement of air in a space partly occupied by solid masses, such as the cargo in a hold, or the carcases in a store, are not clear, and therefore they have arranged that this general fundamental inquiry shall be prosecuted at the National Physical Laboratory.

This example will serve to show how the particular leads to the general; but general solutions are not reached readily, and, therefore, if each particular problem is regarded only as the door to the general, the number of problems which can be undertaken by the small staff at the disposal of the Board is limited.

The papers on the practical engineering aspect of cold storage were so numerous, and the impression which the Congress left upon one was that the progress made on the purely technical side has been so considerable, that it threw into strong relief the inadequacy of our knowledge on the fundamental problems of biology.

A Congress such as the one under review, with its strong international backing, should have been the occasion for a frank review of the situation and for discussions on the fundamental problems with which the industry is faced. The proceedings of these successive congresses could be made to serve as definite landmarks in the history of the science of refrigeration by epitomising the advances made in the intervening years both in pure and applied science, in so far as they relate to the preservation of perishable food-stuffs, and by formulating the general plans of attack on the new problems.

EZER GRIFFITHS.

Mechanism of Cell Growth.

IN the higher plants, new cells are formed and new tissues arise by the activity of certain definitely localised and clearly characterised tissues, the meristems. In the Dicotyledon, these are found at the apex of root and shoot, that is, at either end of the growing axis; in addition, two continuous cylinders of meristem, the cork phellogen and vascular cambium, run lengthwise through the axis and contribute to its subsequent increase in girth. Within these meristems proceeds the construction of new protoplasm, with subsequent mitotic division into new cells as nuclear and cytoplasmic substance accumulates. In such a plant, then, the fundamental metabolic synthesis inseparable from growth, with the subsequent multiplication of the cells of the embryonic tissue, can be visualised as proceeding in strictly localised regions, and the question as to the conditions which promote such growth and division can to some extent be investigated experimentally. Within recent years the meristems have been examined from this point of view. It is clear that if their investigation gives any information as to the condition favouring such a fundamental process as the growth and multiplication of embryonic cells, this information may have very general importance and illuminate a wide range of problems.

From this point of view, an article by Friedl Weber in *Die Naturwissenschaften* for April 18 is of exceptional interest, as it reviews the recent plant physiological approach to these problems from a wide angle and with a wealth of documentation (for citation to original papers referred to below, reference must be made to Weber's paper).

The best known contribution to the conditions governing meristem activity is Haberlandt's theory as to the circumstances which give rise to a new meristem when the plant is wounded and a cork phellogen arises as a result. In this case, cells that have differentiated, and ceased to grow, return again to the embryonic state, and Haberlandt traces this to the effect upon these cells of growth-promoting hormones released from the injured cells. Weber examines the view sympathetically, and has himself used it to explain the forcing of buds from their winter's rest by freezing, narcotics, and various other methods by the assumption that the efficacity of the treatment depends upon the release of such hormones as the result of "physiological wounds" within the bud. Schillings' experiments, however, in which stems of flax and hemp, bent so that they droop earthwards, grow vigorously in the region of the flexure, tell strongly against Haberlandt's view, as this stimulus to growth disappears, although the injury does not, when the shoot is supported in the erect position after bending. But the greatest disadvantage of Haberlandt's view is that it throws no light upon the normal meristematic activity of the uninjured plant.

From this point of view, therefore, Weber finds a wider significance in the views recently developed by Priestley and Woffenden. These investigators similarly start from an examination of wound cork, but the conclusions they reach that its formation depends upon, first, a blocking of the wounded surface, and then an accumulation of sap in the walls and intercellular spaces below this block, enable them by consistent use of the same developmental factors to give a causal explanation of the position of the normal cork phellogen clothing root and stem. Weber then proceeds to a discussion of the more general suggestion as to the conditions for activity of the intercalary meristems of the Dicotyledon recently advanced by Pearsall and Priestley. These authors have pointed out that these two cylinders of meristem appear to be functioning across two reverse gradients of hydrogen ion concentration, the vascular cambium lying between acid xylem within and relatively alkaline phloem without, whilst the cork phellogen has within it the cortex at about P_H6, but outside it cells, the walls of which are bathed in fatty acids with a reaction of P_H3. Weber examines in the light of a wealth of relevant data the suggestion of Pearsall and Priestley that protoplasmic synthesis, and therefore meristem activity, takes place, across this gradient, at the iso-electric point of the cell proteins, the protoplasm at this reaction losing water to cells on either side which, being at other points on the hydrogen ion gradient, swell and vacuolate, withdrawing water from the meristem.

Weber points out that many other physico-chemical properties of the colloidal state of protoplasm are involved in addition to the power of absorbing water, and emphasises that the delicate equilibrium of these properties, which alone permits of protoplasmic synthesis and mitotic division, probably will only be maintained over a limited range of hydrogen-ion concentration. From this point of view, he re-examines Kühns' classical experiments upon nuclear and cell division in Amœba, and directs special attention to the experiments which, by micro-dissection or

by other methods, throw light upon protoplasmic viscosity, and show that alterations of viscosity are quite generally characteristic of mitosis and the activities of embryonal cells.

From the same point of view, Weber points out that high temperatures, narcotics, and other factors influencing mitosis are factors capable of influencing protoplasmic viscosity, as shown by Heilbrunn in his experiments upon sea-urchin eggs. Similarly, Koernicke has shown that under X-rays, and Hartmann that at high temperatures, all the cells of the meristem of the root apex vacuolate. Weber also points out that the rounded nucleus characteristic of the embryonic cell suggests a different and more plastic physical state of nuclear protoplasm, so that the shape is more controlled by surface tension than in the case of the variously shaped nucleus of the differentiated cell that has ceased to divide.

Weber marshals much evidence to show that the hydrogen-ion concentration of the medium can affect the physico-chemical state of the protoplasm, and directs attention to Spek's interesting suggestion that at mitosis, a base, the bye-product of nuclein synthesis, escapes into the cytoplasm with consequent swelling of the plasma colloids and as a result a stimulus to increased nuclein synthesis, so that the process is autocatalytic. Spek explains the cessation of cell division as brought about by a change in permeability permitting increased entry of salts, which neutralise the action of the base released from the nucleus. Certainly in the mitosis of sea-urchin eggs the influence of the hydrogen-ion concentration of the medium has been established as in the experiments of Vles and his co-workers. Lyon has shown that the carbon dioxide production during mitosis varies at the different stages recognised by the cytologist, whilst Jacobs has tried to correlate these striking fluctuations in carbon dioxide output with the equally striking viscosity changes. As Weber points out, such fluctuation of carbon dioxide output will influence the difference between the reaction of the egg plasma and the outside medium.

The rhythm of cell division may find some explanation in the respiratory production of carbon dioxide. Thus Lapicque has shown that the reaction of the medium in which Spirogyra is growing is affected by carbon dioxide production in the dark and its disappearance during photosynthesis in light, and Weber suggests that here may lie the explanation of the fact that cell division in this plant occurs only at night.

Starling is cited for the view that the problem of cancer is the problem of the control of cell growth. Recent studies of cancer with physico-chemical methods enable Weber to refer to investigations indicating that the cancer cell owes its peculiar growth qualities to the medium, the tumour plasma, in which it lies, and that one important factor of this medium is hydrogen-ion concentration.

Weber thus brings a very wide range of phenomena of great general interest under review, and points out in conclusion that the suggestion of Pearsall and Priestley, that the hydrogen-ion concentration is a material factor in meristematic growth, admits of experimental investigation, Heilbrunn, Meier, Endler, and Robbins, amongst others, having suggested methods for determining the iso-electric point of the protoplasm.

Cambridge and the Royal Commission.

PROVISIONAL SCHEME.

THE University Commissioners have communicated to the University of Cambridge a provisional scheme for the inauguration and organisation of teaching in the University on the general lines of the recommendations of the Royal Commission. They propose to draft necessary statutes and ordinances themselves to carry out their scheme, but publish their proposals in outline in order to give members of the University an opportunity of expressing their opinion about the proposals.

It is proposed to constitute as from October 1, 1926, eleven faculties in the arts group and seven in the science group In the science group there are to be agriculture, biology, engineering studies (including aeronautics), geographical and ethnological studies, mathematics (including astronomy and geodesy), medicine, physics, and chemistry. The faculty of biological studies is to be divided into two sections, each with separate departments: A. (1) botany, (2) genetics, (3) geology, and (4) zoology. B. (1) biochemistry, (2) experimental psychology, (3) human anatomy, (4) parasitology, (5) pathology, (6) physiology. The faculty of physics and chemistry is to include the following departments: (1) astrophysics, (2) chemistry, (3) mineralogy, (4) physics.

The separate faculties will be composed of official university and college teachers in the appropriate subjects (including fellows of Girton and Newnham Colleges) and others appointed by the Board of the Faculty. The Board of a Faculty will consist of the professors in the subjects concerned, a certain number of nominees of the faculty, of the Board and of the Council of the Senate, together with representatives of cognate studies. The average number of members of a Board, according to the detailed scheme suggested by the Commissioners, is sixteen.

The new General Board of Studies is to consist of four members elected by the group of arts faculties, four members elected by the group of science faculties, four members of the Council of the Senate, and two persons nominated by the Council, with the vice-chancellor as chairman. The number of university lectureships (and demonstratorships) would be determined by the University for each faculty on the recommendation of the Board of the Faculty and of the General Board. The appointments would be made by a standing committee for each faculty of the vice-chancellor, the head of the department, three members of the Board of the Faculty appointed by the Board, and two persons appointed by the General Board. The normal tenure would be for three years in the first instance, and, on renewal, so long as the lecturer was doing his work satisfactorily, until the retiring age of sixty-five.

According to the scheme, all fees for lectures announced by the General Board would be paid to the University into faculty or departmental funds, the lecturers to be paid a basic wage by the faculty for an obligatory minimum of teaching work, with a scale of increments on the basic salary, with continued tenure of a post, and with additional payments for extra work done. It is contemplated that the University will be able to inform the faculties, before they finally create their new lectureships, how much money, if any, the University can put at the disposal of each faculty board in addition to the fees credited to it.

A great amount of work must lie before the Commissioners and various bodies of the University in getting the scheme into working order, a great amount of work must have been done on it already. It represents the completion of a process which has

been going on for a considerable time by which the organisation of the teaching and the actual teaching itself has been slowly but steadily passing out of the hands of college lecturers into those of university staffs. The creation of the large scientific laboratories and departments has accelerated the change, which is already half completed. The University takes more conscious control of developments and changes in studies. It remains to be seen whether improved organisation will mean better efficiency or whether the initiative of individual colleges fostered in the past may be crushed by the burden of machinery. As ever in such cases, it all depends on the quality of the men who become responsible for driving the machine.

Among other proposals which the Commissioners contemplate is permission for a professor to be continued in office after reaching the age of sixty-five up to, but not beyond, the age of seventy. They also contemplate throwing open all professorships, readerships, lectureships, and examinerships to women. This proposal to put women teachers on the same footing as men in the matter of the organisation of teaching removes one of the serious grievances remaining for women at the University. Even though they may not vote in the final decisions of the Senate on matters of educational policy, they will be free as members of a faculty to take part in the more important preliminary discussions which ultimately determine the changes of policy. The Commissioners do not propose to force upon the University, against its expressed wish, the admission of women to membership and to a share in the government of the University. That is to be left to the University itself to settle.

University and Educational Intelligence.

BRISTOL.—A prospectus of the Faculty of Engineering, which is provided and maintained by the Society of Merchant Venturers in the Merchant Venturers' Technical College, Bristol, has just reached us. Courses of study are available at the College for persons intending to engage in civil, mechanical, electrical, or automobile engineering, and particulars of these courses are given in the prospectus. The ordinances and regulations relating to degrees and diplomas in engineering subjects are included, and some particulars of the Bristol sandwich-system of training engineers are also given. The prospectus can be obtained from the registrar of the Merchant Venturers' Technical College, Bristol.

CAMBRIDGE.—Mr. W. S. Thatcher has been appointed Censor of the Non-Collegiate Students.

LEEDS.—With the view of encouraging the revival of the University Extension movement, the West Riding Education Committee has decided to make towards the cost of an approved course of extension lectures such a grant as will cover the actual deficit incurred, or 75 per cent. of the total expenditure, on condition that at least 30 persons undertake to enter for the whole course, and that the lectures are open to the public at a charge not exceeding 3*d*. per single lecture. The fees for lectures range from 22*l*. 10*s*. for a course of 6 to 76*l*. 10*s*. for 24, and the only other charges besides incidental local expenses, such as hire of hall and advertising, which are borne by the local committee, are the lecturer's travelling expenses and a fee of not less than two guineas (varying according to the number of candidates) for the examination, if one is held. The panel of lecturers includes 33 members of the University staff, of whom 8 are professors. The range of subjects is very wide: the following are specimen headings—Greek ethics, archæology and architecture, phonetics, the Irish literary movement, social psychology, riches and poverty, Spanish art, How the Empire is governed, French history since 1815, the gases of the atmosphere, fresh-water biology, types of respiratory structure, the antiquity of man, radio-activity, application of colloid chemistry to industry, British birds, enzymes, bacteriology from the medical, public health, and chemical points of view, personal hygiene.

AN advisory chemist in the faculty of agriculture, University College, Reading, is shortly to be appointed. Particulars are obtainable from the Registrar of the College.

THE trustees of the Busk studentship in aeronautics, founded in memory of Edward Teshmaker Busk, who lost his life in 1914 while flying an experimental aeroplane, have appointed Mr. John Cowan Stevenson, of the University of Glasgow, to the vacant studentship.

A DEMONSTRATOR is required in the mathematics and mechanics department of the Royal College of Science, South Kensington. Candidates must possess engineering experience, and send their applications to the secretary of the college not later than September 5.

APPLICATIONS are invited by the Director of the School of Medicine, Cairo, for the professorships in the school, of Physics, Clinical Medicine, and Clinical Surgery; also for the post of lecturer in physics in the institution. In the latter case candidates must be of Egyptian nationality. Applications must reach the director by September 15 at latest.

APPLICATIONS are invited for the appointment of lecturer in physics and the directorship of the Viriamu Jones Physical Research Laboratory of the University College of South Wales and Monmouthshire. Applications (six in number) and testimonials must be received not later than September 10 by the Registrar of the College, Cathays Park, Cardiff.

THE University of Calcutta "Poverty problem study" organisation which has been at work for some years has succeeded in promoting the formation of a limited liability company for the establishment in the Paresnath Hills of co-operative educational colonies, such as Capt. Petavel, Principal of the Kassimbazar Institute, has been advocating in his university lectures on the "Poverty problem." The Company proposes to set up an agricultural college "where professors and students will be provided with sufficient land for self-support and education." Each student on completion of his course, and having obtained a university diploma, would be helped to acquire, as a member of a colony, a plot of ground with bungalow, well, bullocks, plough, etc. The scheme is described in the first number of a new periodical, "Bread and Freedom," edited by Capt. Petavel.

INTERCHANGE of teachers between universities within the Empire is one of the subjects that were discussed at the recent Imperial Education Conference in London organised by the League of the Empire. One speaker described as an object lesson to the universities of the Empire the Chicago University summer school, which attracts professors and lecturers from all parts of the United States as well as from abroad. We have lately received a University of Colorado Bulletin which gives an account of this University's summer quarter, extending from the middle of June to the end of August. This year the staff includes no less than fifty instructors from other

institutions, among whom are professors and other members of the staffs of universities in twenty other States. Many are, no doubt, attracted by the University's advantages of climate and picturesque surroundings. A permanent camp is maintained during the summer quarter at Arapahoe Falls in the Rocky Mountains, about 25 miles distant, for the benefit of university students and teachers.

Adult education in Ireland was the subject of an address by Mr. George Fletcher, of the Department of Agriculture and Technical Instruction for Ireland, at the annual congress of the Irish Technical Instruction Association on June 4. For many years there have been complaints that the effectiveness of technical instruction in Ireland is much less than it might be, because the standard of general knowledge of the students is low. It is mainly on the ground that it would remedy this defect that Mr. Fletcher urges the inauguration of schemes for the extension of University teaching in towns and for the establishment of community centres with village halls in rural districts. Hitherto there has been no movement in this direction in Ireland comparable with the University Extension movement in England. The Royal Dublin Society, a few years ago, allocated 200*l*. for the initiation of courses of lectures; a panel of lecturers was framed and syllabuses were prepared, but the work had barely begun when travelling became almost impossible, and the scheme was abandoned as impracticable. Its resuscitation has now been recommended. It is thought that the transfer of Technical Instruction from the Department of Agriculture and Technical Instruction to the Department of Education, which took place on June 2, 1924, may tend to the establishment of conditions favourable for voluntary enterprises in the field of adult education.

"Non-university resources for graduate study and research" formed the subject of two interesting papers read before the Association of American Universities last November and published recently. President Wilbur, of Stanford University, argued in favour of all new research projects being brought directly into the domain of some university or group of universities, and also against the constitution of "research professorships" and special research institutes isolated from "the great normal university current." In certain fields the Pasteur Institute, the Rockefeller Institute in New York City, and other organisations for research independent of universities have not only achieved conspicuous success but have also "set the pace" for university research work. This kind of development of research is, however, less advantageous to the community than development within the universities, for the following reasons: its overhead expenses are greater, it does not provide such good opportunities for the training of young research students, or for the benefits of membership of a faculty and association with members of other faculties, and it tends to involve a more urgent pressure to produce visible results. President Wilbur directed attention to the recent decision of the Tanners' Council to place its research project at the University of Cincinnati, the Council having come to the conclusion that "the university atmosphere is the right place for research." This view may be compared with Sir Frank Heath's pronouncement at the May conference of British universities to the effect that modern demands seem to point to the necessity for at least four types of organisation for research: universities, central research institutes, industrial research laboratories run by the industries themselves, and laboratories of individual firms.

Early Science at the Royal Society.

August 17, 1664. The engine to measure refractions was produced, examined and approved of, and Mr. Hooke the inventor of it, appointed to begin at the next meeting to try experiments in it; as also to give a description of this engine to be kept in the Register-book.—Dr. Goddard was desired to describe his instrument with strings and pulleys intended for a hygroscope, and to take notice of the uselessness thereof, as it had been hitherto contrived, and to think upon another way.

1687. Sir John Hoskyns communicated the following receit of one Simeon Pauli for a varnish to coat and preserve dried plants; infuse in spirit of wine the seeds of wormwood; and then dissolve therein as much gum elemi as it will take; and with this varnish cover the plant. This was thought to be a good means to preserve insects from perishing.

August 18, 1670. Mr. Hooke reported to the society, that he had already found so much, as to suspect some parallax of the earth's orb, and conceived, that it would be more sensible half a year after. He said, that by a perpendicular tube he observed the stars, which pass our zenith, at different times of the year, and by noting, whether the same star be at those different times of observation at the same distance from the zenith or not; concerning which he affirmed, that a certain star was then less distant from the zenith than it had been a month before.

August 19, 1680. The subject of filtration and rising of liquors in small pipes was debated. The difficulty of them appeared; viz., first, from the imperfect exhaustion; and secondly, from the uncertainty of the rising of the same liquor in the same pipes at several times.—Dr. King related that he had observed six or seven sorts of animals, a thousand of any of which were less than a globule of blood.

1663. Mr. Hooke gave in a picture of the stones taken out of the heart of the earl of Balcarres. The lord viscount Brouncker promised to get the same done in plaister.

August 20, 1662. Dr. Wallis's written discourse about Dr. Goddard's experiment of weighing glass canes with the cylinders of quicksilver standing in them according to the Torricellian experimt. was delivered in; but because the understanding thereof depended greatly upon the schemes annexed to it, the reading of it was deferred till the next meeting: and the amanuensis was ordered to draw the said schemes in great upon a large paper that every member might look upon them with conveniency.—Mr. Powle to be written to by Mr. Oldenburg, that he would send the society an exact description of the whispering place in the cathedral of Gloucester.

1684. Mr. Henshaw having propounded to try, whether a thermoscope, exhausted of air, with the liquor in it, exhausted of air too, might be sensible of cold and heat, as ordinary thermoscopes are; the thing was tried, and found that the effect was not sensibly altered by the absence of the air.

August 21, 1661. Mr. Colwall read his "Relation concerning the making of Alum," for which he received the thanks of the society, and it was ordered to be registered.

August 22, 1678. Mr. Hooke delivered to the Society an antient urn of glass, taken up in Spittlefields upon digging cellars there, presented by Sir Christopher Wren. There was this remarkable in it, that it seemed to be made after quite another manner than that used by the present workman in that art, it having no place at the bottom thereof; nor any visible sign how it could be held, whilst the lip and handle thereof were joined to the body.

Societies and Academies.

PARIS.

Academy of Sciences, July 16.—M. Guillaume Bigourdan in the chair.—V. Grignard and R. Jenkins: Mixed organo-aluminium compounds. The iodides of monoethyl- and of di-ethylaluminium. Dry ethyl iodide reacts with aluminium powder in the absence of oxygen, giving a mixture of the compounds $((C_2H_5)_2 . Al I)_2$ and $(C_2H_5 \cdot Al I_2)_2$. Both compounds are spontaneously inflammable in air, and in contact with water give pure ethane.—Jacques Chapelon: The representations of an integral number by certain forms with six variables.—Enrico Bompiani: The second fundamental form of a surface.—G. Maneff: Gravitation and the principle of equality of action and reaction.— — Lémeray: General conditions which must be satisfied by a theory of the universe in agreement with general relativity.—E. Tournier: A new method of calculating the power of the reciprocating steam engine.—Louis Roy: Electromagnetic waves in continuous media in motion.—Maurice Curie: The photo-electric effect and temperature.—P. Lebeau and Ch. Bedel: The estimation of carbon monoxide. The reagent recently proposed by Damiens (cuprous oxide dissolved in concentrated sulphuric acid) for the absorption of carbon monoxide is modified by the addition of β-naphthol. This addition renders the Damiens reagent more stable, and less liable to absorb oxygen.—E. Kayser and H. Delaval: Radioactivity and nitrogen-fixing organisms.

CAPE TOWN.

Royal Society of South Africa, June 18.—Dr. A. Ogg, president, in the chair.—R. S. Adamson: Preliminary note on secondary growth in some Iridaceæ. Three closely allied genera, Nivenia, Witsenia and Klattia, possess woody stems with continued secondary growth. The secondary growth has the same general features as that described for the arborescent Liliaceæ, but these plants differ in two features:—(1) The secondary bundles, or the inner ones, are very close together, often in contact. The radial arrangement of cells is obscured to a large extent. The bundles arise from a number of cambium cells. (2) In old stems the secondary tissues are arranged in zones (annual rings), a feature not previously described for monocotyledons.—Sir Thomas Muir: Note on systems of determinants with sets of deleted elements.—J. Moir: Colour and chemical constitution, Part XIX., Organic fluorescence.—S. H. Haughton: On a skull and partial skeleton of *Mesosuchus browni*, Watson. This paper contains the description of the only known complete skull of *Mesosuchus browni* from the Cynognathus beds of Aliwal North, as well as of the front half of the skeleton. The relationships of the form with Youngina, the Sphenodontia, the Rhynchosauria, the Lizards, Howesia, and the Thallatosauria, are discussed, and it is concluded that Mesosuchus may be placed in a new family, which is called the Mesosuchidæ, and placed in a new sub-order of Diapsid reptiles, the Mesosuchia.—C. W. Kops: A South African life table based on the European male population census. (Communicated by Prof. J. P. Dalton.) The life table is based on the census returns of 1918 and 1921, and the deaths during the years 1919–1921. The function graduated is q_x. The graduation was performed by fitting three curves to the data—a quadratic, together with an exponential function for ages 0 to 15, a first degree function, together with an exponential for ages 24 to 108, and these curves are joined by a cubic function having first order contact with each of the other curves. A Makeham graduation was also applied from age 20 to the end of the table. Both graduations are then compared with standard tables from other countries. Graphical comparisons are also made in the case of each graduation.

ROME.

Royal Academy of the Lincei, May 18.—B. Grassi: The transmission of malaria. In some years marked discordance exists between the number of Anopheles and the intensity of the malarial epidemic, the number of malarial individuals at the outbreak of the epidemic being insufficient to justify such discordance. The amount of semilunar gametes in some localities appears inadequate to explain the epidemiology of this form of malaria, except on the supposition of a mutation of the tertian parasites or a hybridisation of the latter with the estivo-autumnal parasites. A general incongruity is observed between the abundance of the gametes and the new infections, the gametes abounding particularly in winter and spring, during which seasons the Anopheles has no opportunity of undergoing infection.—A. Russo: Mixed individuals formed from the ex-conjugants, after true conjugation in *Criptochilum echini* Maupas, and the origin of the gametogens. These mixed individuals are shown to be differently constituted, not only from the diverse origin of the nuclei composing their nuclear apparatus, but also as regards the quantity of nuclear substance present. Of the four nuclei which go to make up this nuclear apparatus, one only assumes the sexual function for the formation of gametes.—G. Vranceanu: Stability of rolling of a disc.—M. Maggini: Distribution of the radiating power on planetary discs, determined with the interferometer. Investigation of the distribution of luminous intensity on the apparent discs of the planets Uranus and Vesta shows that, as is the case with Jupiter and Saturn, the peripheral regions are less luminous than the central ones.—F. Signore: Temperature measurements made in Lake Lucrino and in the neighbourhood of Maricello during 1922–1923.—G. Piccardi: Further observations on a thermal method for the study of gaseous systems. Experiments on a number of the more permanent gases by means of the apparatus now described give results in satisfactory agreement with the theory previously advanced.—G. R. Levi and A. Ferrari: Crystalline lattices of magnesium hydroxide and carbonate. The fundamental element of magnesium hydroxide is a parallelopiped having a rhombic base of side 3·114 Å and an acute angle of 60°, the height being 4·735 Å. The corresponding density would be 2·40, which agrees perfectly with the actual values for the natural and artificial products.—O. Munerati: Artificial nocturnal illumination as a means of accelerating the phases of the vegetable cycle.—R. Perotti and F. Aureli: Ammonifying power of arable soil. The method of measuring the ammonifying power of soils by means of nutrient solutions reveals marked differences corresponding with those found in the condition of the vegetation of the soils. With "normal" soils, which exhibit an alkaline reaction, the aptitude to the micro-biochemical production of ammoniacal nitrogen usually suffices for the needs of vegetation.—R. Perotti and G. Grandis: Measurement of the nitrifying power of arable soil. The optimum conditions for the measurement of the nitrifying power of soil by the method of nutrient solutions are defined.—P. Dorello: Observations on the erectile body of the penis of the genus Helix.—A. Busacca: Structure of the living crystalline fibre. The protoplasm of the fibre of the crystalline lens exhibits formations of undoubted mitochondrial character. These formations being mobile, the fundamental substance of this protoplasm is not a solid hydrogel but one of some fluidity, the latter resulting from the high degree of

imbibition experienced during the development. Although it has undergone very marked differentiation, the protoplasm preserves unchanged all the attributes of true protoplasm and cannot be regarded as a metaplasmatic substance.—E. **Momigliano**: Behaviour of lipoids in nephropathy.

VIENNA.

Academy of Sciences, March 6.—F. **Reinitzer**: Researches on olive-resin.—R. **Weiss** and E. **Freund**: The action of organic magnesium compounds on phthalonitril, I.—G. **Weissenberger** and L **Piatti**: The behaviour of creosole towards alcohol, ether, and acetone.—V. **Brehm**: Diagnoses of new Entomostraca, Part III. Report from the Handel-Mazetti Expedition to China, 1914–1918, supported by a grant from the Vienna Academy of Science. New species are, *Diaptomus bidens*, Yunnan, and *D. Walterianus*, Yunnan.—G. **Jager**: The lines of force in the special theory of relativity.

March 13.—F. **Feigl** and A. F. **Lederer**: On diphenylcarbazon and its salts, also on the supposed diphenylcarbodiazon.—J. **Krames**: Regular surfaces of the third order, the infinite curves of which doubly osculate the absolute conic section.

March 20.—K. **Mader**: On the use of the Eotvös balance with large masses at close distances.—E. **Müller**: A new method for combined measurements of the capillary constant and of the internal friction in viscous liquids.

April 3.—E. **Heinricher**: Sleeping reactions of the inflorescences of *Dimorphothera pluvialis* (L). The principal factor in the sleeping reactions of *Dimorphothera pluvialis* is change of temperature.—D. **Pettersson**. On the maximum range of the particles discharged from radium C (Mitt. d. Ra-Inst's No. 163). The long-range particles assumed by Bates and Rogers to be discharged from radium C have been examined under conditions excluding the production of secondary particles. The number of particles of ranges exceeding that of the normal α-particles was found to be less than a few per cent. of the number found by these authors.—E. **Landau**: On the inapplicability of Pfeiffer's method in the analytic theory of numbers.—R **Weiss** and J. **Korczyn**: (Trimethylene-triphenyl-methane-triketon).—A. **Merz**: Investigations of elastic after-effects by an acoustic method.—M. **Eisler** and L. **Portheim**: On insulin-like substances and their action on the exchange of the carbo-hydrates (Preliminary communication). Production of an insulin like substance from seeds of *Phaseolus multiflorus*, and preliminary experiments on the influence of this substance on the exchange of carbo-hydrates in the plants.—I. **Robinsohn**: The colouring of the stigmata—Stigmatochromy. A morphologic-biological method for researches on flowers.—H. **Handel-Mazzetti**: Plantæ novæ Sinenses diagnosibus brevibus descriptæ.—Fuller abstracts for the Vienna Academy of Sciences in 1923 are given in *Die Naturwissenschaften* for May 9 and May 16, pp. 372 and 394. These contain earlier papers on Triton by Weiss, on meteorology by Exner, and on cave-bears by Abel and others.

May 8.—Alois **Zinke** and Franz **Hanselmeyer**: Researches on perylene and its derivatives (Communication VI).—Alfred **Wagenhofen**: Contributions to our knowledge of para-orsellinic-acids. The aim of the work was the verification of the influence of the methyl-group on the retention of the carboxyl-group in many-substituted benzoic acids, for which the para-orsellinic-acid was chosen as starting-point. The nitrification of the dimethyl-para-orsellinic-acid-methyl-ester led to a mono-nitro-substitution product.—Elisabeth **Kara-Michailova** and Hans **Pettersson**: Communication of the Radium Institute, No. 164. On the measurement of the relative brilliancy of scintillations. A method is described for the determination of the relative brilliancy of scintillations and of their application for a confirmation of the particles deviating from quartz under α-particle bombardment as H-particles.—Anton **Kailan** and Roman **Obogi**: On the question of purifying glycerine from volatile fatty-acids and their esters. The addition of alkali works prejudicially on the distillation of glycerine, since it does not diminish, or does not appreciably diminish, the acid figure in the chief fraction whilst the ester figure is very strongly increased.—Kasimir **Atynski**: The preparation of selenides from selenium hydride and metallic salt solutions. The selenides are appreciably less stable than the sulphides.

May 14.—P. **Flach**: Cytological researches on vessel formation in *Cucurbita Pepo*.—Frau Dr. Helene **Kurz**: *Pholidopus* (*Achtheinus*) *intermedius* and *Dissonus glaber*, two new species of the family Caligidæ.

WASHINGTON, D.C.

National Academy of Sciences (Proc. Vol. 10, No. 6, June).—W. M. **Davis**: The formation of the Lesser Antilles. The banks on which the Lesser Antilles stand represent reef-enclosed lagoon floors, formed according to Darwin's theory of coral reefs and modified by the processes of the glacial-control theory. The scheme of development is as follows. First there is eruptive growth of a volcanic island on a subsiding foundation; subsidence continues after growth ceases and lagoon deposits increase within the up-growing barrier reef. Reef abrasion and headland cliffing occur whenever the Glacial period intervenes. The second cycle commences by upheaval or uptilting and may interrupt the first cycle at any stage. Some of the Lesser Antilles are first stage islands and some belong to the second period.—G. R. **Putnam**: Radio fog signals for the protection of navigation; recent progress. The radio compass is considered to be the most important instrument invented for use on shipboard since the introduction of the magnetic compass. It is used in conjunction with radio fog signals which, in the United States, consist of characteristic signals on a wave-length of 1000 metres. There are 11 such beacons in the United States waters and 12 outside. About 291 vessels now have radio-compasses or direction finding apparatus. The spark transmitters are to be replaced by tube transmitters. With the present apparatus and conditions of use, no serious error is caused by the "night" effect.—D. F. **Jones**: Selective fertilisation among the gametes from the same individuals. Pollen carrying a dominant factor is better able to accomplish fertilisation in a sporophyte carrying the same factor than pollen carrying the corresponding recessive factor.—W. E. **Castle**: The Japanese rabbit and gametic purity. The so-called "Japanese" rabbit is yellow, mottled or brindled with black. The brindling seems to depend on the formation of a mosaic type of gene, very rare in occurrence but very stable when once produced, which is due to imperfect segregation between black and yellow, themselves simple allelomorphs.—K. **Sax**: The nature of size inheritance. Experiments with beans show that differences in size and total yield are, to some extent, due to factors linked with qualitative factors which are subject to Mendelian inheritance. Analysing Castle's rabbit data by determining partial correlations with body weight held constant, it is concluded that Castle is correct in stating that the genetic agencies affecting size in rabbits are general in action. The data of other workers using different animals indicate that body proportions may not be entirely dependent on factors which affect body weight.—E. B. **Wilson** and W. J. **Luyten**: A statistical discussion of sets of precise astronomical measurements. II—

Proper motions. Allegheny and McCormick Observatories issue photographic proper motions in Right Ascension with reference to the mean of the comparison stars. The values are compared with meridian circle determinations (Boss), from which it appears probable that a factor of about 1·4 should be applied to the probable errors.—Raymond **Pearl**: The influence of alcohol on duration of life. Accurate information has been collected for a group of more than 6000 white persons of a working-class population. Exhaustive data were obtained and the material classified in eight groups according to alcohol consumption. Calculation of life-tables and so on shows that at every age from 30 to 100, moderate drinkers of both sexes have a slightly *higher* expectation of life than abstainers. Male heavy drinkers have a markedly lower expectation of life than moderate drinkers from 30 to 100 and than abstainers from 30 to 60; from 60 onwards the advantage is slightly to the heavy drinkers, possibly due to the selective effect of high mortality among heavy drinkers prior to 60. For females, expectation of life is markedly lower for heavy drinkers than for moderate drinkers or abstainers from 30 to 100.—W. M. **Wheeler**: Two extraordinary larval Myrmecophiles from Panama. Both were found in ant nests. One is broad, regularly elliptical, 5·7 mm. long, with flattened creeping-sole bordered with minute red papillæ; the integument is smooth, pale blue, and bears regular longitudinal white scales which on pupation were thrown violently off. No imaginal fly was obtained. It has been named *Microdon æolidiformis*. The other form has an anterior portion which can be withdrawn into the carapace-like abdominal region. The latter is covered with a mosaic of regular hexagonal chitinous plates, the dorsal surface bearing regularly arranged sense-organs; there is no creeping-sole. It has been named *Nothomicrodon aztecarum*.—W. B. **Cannon** and A. **Querido**: The rôle of adrenal secretion in the chemical control of body temperature. The rate of heart beat in animals with denervated hearts was increased 12 to 64 per cent. by cooling the body. The effect is not obtained if the adrenal glands are made inactive though shivering is still produced. It is argued that increased adrenal secretion can augment metabolism to counteract the effects of cold.—W. B. **Cannon** and J. R. **Pereira**: Increase of adrenal secretion in fever. Experiments similar to those of the previous paper show that fever is associated with increased adrenal secretion.—E. W. **Brown**: An explanation of the gaps in the distribution of the asteroids according to their periods of vibration. Instability of motion is suggested, on a mathematical basis, as the cause of the gaps.—J. H. **Oort** (1) Note on the difference in velocity between absolutely bright and faint stars. For stars with total velocities less than 65 km or for stars moving in a direction opposite to the motions of high velocity stars, the average velocities for giants and dwarfs are nearly equal. There is no hint of increase of velocity with decreasing mass. (2) On a possible relation between globular clusters and stars of high velocity. Curves showing the galactic distribution of globular clusters and the antapices of the motions of high velocities alike show marked avoidance of the Milky Way.—W. J. **Luyten**: Note on some statistical consequences of the luminosity law.—W. C. **Rufus**: Atmospheric pulsation of the Cepheid variable, η Aquilæ. Line displacements from different elements and at different levels of the atmosphere of a star have been studied. Generally, compression of the atmosphere occurs after maximum compression of the star as a whole, thus accounting for the retardation of the light maximum. The humps of the velocity-difference curves of the various layers are synchronous with the *Stillstand* of the light curve; the latter appears to be due to a stage of comparative rest in the star's atmosphere.—B. de **Kerékjártó**: On parametric representations of continuous surfaces.—A. H. **Compton** and Y. H. **Woo**: The wave-length of molybdenum $K\alpha$ rays when scattered by light elements. The secondary radiators used were lithium, boron, carbon, water, sodium, magnesium, and aluminium, and in every case, after scattering at about 125°, an addition to the usual $K\alpha$ peak, there was another in the position predicted by Compton's quantum theory of scattering. With sodium and aluminium, there is perhaps some evidence of tertiary scattering in accordance with the theory of Clark, Stifler, and Duane.—E. C. **Kemble**: Quantisation in space and the relative intensities of the components of infra-red absorption bands. Bohr's correspondence principle applied to the evaluation of the intensities of lines in the infra-red absorption bands of diatomic gases gives values contrary to experiment in the case of the hydrogen chloride band at 3·5 μ. Better results are obtained by assuming a slight precession of the orbital plane about the lines of the earth's magnetic field.—L. **Thompson**: The ballistic (air resistance) function.—W. A. **Setchell**: Ruppia and its environmental factors. Two distinct forms of *Ruppia maritima* L. were found at Richardson Bay, California. At stations subject to tidal conditions, the plants were perennials with long, spirally curved peduncles, and most of the fruits were robust, rounded and only slightly curved without pronounced beak (var. *longipes*). Plants growing in shallow pools were annuals with practically opposite characteristics (var. *rostrata*). Laboratory experiments show that both varieties tolerate a wide range of salinity, P_H and daylight-darkness ratio; temperatures of 15-20° C. are necessary for germination, and 20-25° C. for growth and reproductive activity.

Official Publications Received.

Department of Agriculture, Ceylon. Bulletin No. 69: Notes on the Habits and Life-History of the Indian Glow-worm (An Enemy of the African or Kalutara Snail). By Dr. J. C. Hutson and C. Douglas Austin. Pp. 60. (Peradeniya, Ceylon.) 40 cents.

Canada. Department of Mines: Geological Survey. Bulletin No. 38 (Geological Series No. 43): Contributions to Vertebrate Palæontology. By Charles W. Gilmore. Pp. ii+64+12 plates. Memoir 136 (No. 117 Geological Series): Arnprior-Quyon and Maniwaki Areas, Ontario and Quebec. By M. E. Wilson. Pp. iii+152+12 plates+4 maps. Memoir 137 (No. 118 Geological Series). Palæontology of the Silurian Rocks of Arisaig, Nova Scotia. By F. H. McLearn. Pp. ii+179+30 plates. (Ottawa: F. A. Acland.)

Department of Commerce: U.S. Coast and Geodetic Survey. Serial No. 258: Effect of Variations in the assumed Figure of the Earth on the Mapping of a large Area. By Walter D. Lambert. (Special Publication. No. 100.) Pp. iii+35. (Washington: Government Printing Office.) 5 cents.

Department of the Interior. Bureau of Education. Bulletin, 1924, No. 21: Practices and Objectives in Training for Foreign Service; Report of the National Conference on Foreign Service Training, Washington, December 26, 1923. Prepared by Glen Levin Swiggett. Pp. iii+27. (Washington: Government Printing Office.) 5 cents.

Annuaire de l'Observatoire Royal de Belgique, 1925. Publié sous la direction de G. Lecomte. Pp. vi+294. (Bruxelles: Impr. Van Gompel.)

Department of Commerce: Bureau of Standards. Circular of the Bureau of Standards, No. 101: Physical Properties of Materials. 1: Strengths and related Properties of Metals and Wood. Second edition. Pp. 204. (Washington: Government Printing Office.) 40 cents.

Det Kgl. Danske Videnskabernes Selskab. Mathematisk-fysiske Meddelelser, V, 3: On the Effect of Magnetic and Electric Fields on the Mercury Spectrum. By H. M. Hansen, T. Takamine, and Sven Werner. Pp. 40+2 plates. (København: A. F. Høst and Son.) 2.25 kr.

Department of Commerce: Bureau of Standards. Scientific Papers of the Bureau of Standards, No. 487: A Quantitative Study of Regeneration by Inductive Feed Back. By C. B. Jolliffe and Miss J. A. Rodman. Pp. 419-428. 10 cents. Scientific Papers of the Bureau of Standards, No. 488: Thermal Expansion of Molybdenum. By Peter Hidnert and W. B. Gero. Pp. 429-444. 10 cents. Technologic Papers of the Bureau of Standards, No. 258: Strength of Steel Tubing under combined Column and Transverse Loading, including Tests of Columns and Beams. By Tom W. Greene. Pp. 243-276. 15 cents. (Washington: Government Printing Office.)

Liverpool Astronomical Society. Annual Report 1923-1924. Pp. 8. (Liverpool: H. Norman Edge, Hon. Sec., Central Technical School.)

Transactions of the Royal Society of Edinburgh. Vol. 54, Part 1, Session 1923-24: The Deep-Sea Deposits of the Atlantic Ocean. Descriptions prepared under the Direction of the late Sir John Murray, and Discussion of the Results by James Chumley. Pp. ix+252. (Edinburgh: R. Grant and Son; London: Williams and Norgate.) 25s.

NATURE

SATURDAY, AUGUST 23, 1924.

CONTENTS.

Editorial and Publishing Offices:
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.

Editorial communications should be addressed to the Editor.
Advertisements and business letters to the Publishers.

Telephone Number: GERRARD 8830.
Telegraphic Address: PHUSIS, WESTRAND, LONDON

Problems of the Coal Mining Industry.

WHEN Mr. Lloyd George was in power about 1919, various proposals relating to the mining industry were put forward by him; and it may be remembered that they were rejected successively by all the interested parties. The essential points of these proposals have now been re-stated in a report entitled "Coal and Power,"[1] just issued as a slender volume. We are not concerned here with the political aspect of Mr. Lloyd George's suggestions, but it may be worth while to consider the technical and economic sides. As regards coal mining, the suggestions fall into two main groups, namely:

1. The acquisition by the State of mineral royalties. (Incidentally it may be noted that the authors of the report have not decided how far they should go in this respect; in the introduction, the summary of the proposals suggests "purchase of all minerals and royalties by the State," whereas in the body of the report we find the following sentence: "Further, it is to be considered whether the State, when acquiring its coal resources, should at the same time acquire all the mineral resources of the country." Surely the author or authors of this report ought first to have made up their minds as to what they really want to do.)

2. The formation of consultative bodies consisting of miners and mine owners, who are apparently to discuss the problems of the industry. (Throughout, the author or authors of the report overlook the importance of the mining engineer and the mine manager; whenever the technical staff is casually referred to, it is looked upon as part and parcel of the mine ownership; any discussion of the future of the industry that fails to recognise that there are at least three separate bodies to be considered, namely, miners, mine owners, and technologists, must necessarily be imperfect.)

The report examines at some length the reasons for the present disturbed state of the industry, but fails to recognise one of the most serious. A small but active section of the miners' leaders appears to have determined to get the whole of the coal mining industry into its own hands, an operation which these men designate as nationalisation, and apparently they have come to the conclusion that the best way of attaining their object would be to wreck the industry as it now exists.

It is pointed out quite clearly in the report that nationalisation of the coal resources is a matter which can legitimately be undertaken by the State, whereas the nationalisation of the industry cannot. It is well known that there are two forms of mineral ownership. In one, which is adopted by most Conti-

[1] Coal and Power: the Report of an Enquiry presided over by the Rt. Hon D. Lloyd George. Pp xiv+139+16 plates. (London: Hodder and Stoughton, 1924.) 1s. net.

nental nations, the State owns the minerals and leases them to the mine owners; in Great Britain and the United States, the minerals are the property of individuals who may deal with these minerals as they see fit. Both systems operate and operate successfully, but it is a curious fact that the two countries where the minerals are privately owned are those where mining has reached its highest pitch of development, and, incidentally, where the miners' wages are the highest. The present report proposes to purchase the coal royalties, and shows a series of advantages which it claims would result from such change of ownership. Curiously enough, not a word is said about the fact that the Crown already owns quite important mineral areas; for example, it owns all the under-sea coal, and it owns practically all the coal in the Forest of Dean Coalfield. This State-owned coal, however, is leased and dealt with in precisely the same way as the privately-owned coal in the country, and none of the advantages which are claimed for the State ownership of minerals are apparent in the quite considerable tracts of State-owned coal already in existence. Incidentally it may be pointed out that wages in the Forest of Dean coalfield are about the lowest in the whole country.

No reference is made in this report to the very important lessons to be learnt from the United States. In the United States the minerals were originally the property of the State, and at first the Federal Government attempted to lease its minerals, but after something like half a century of experimenting on these lines it was found far better to get the mineral lands as soon as possible into private hands. The author or authors of this report might study with advantage the evidence given by Dr. R. W. Raymond before the 1889 Royal Commission on Mining Royalties upon the methods adopted in the United States. One sentence alone from his evidence may be repeated here: "I have been accustomed to say at home over and over again that it would be better for the United States to-morrow to give up all its mineral land and deliberately convey it to individuals for nothing in order to have somebody own it instead of the Government." In the face of such an emphatic pronouncement, based upon experience, it would surely appear to be a risky experiment to desire to revert in Great Britain to the method of State ownership of royalties. It may be freely admitted that the method is quite workable, seeing that it is in operation in most Continental countries, but there is no evidence that any advantage would accrue from it.

Another point which is emphasised in the report before us is the possibility, if all the minerals were State-owned, of doing away with barriers. Any experienced coal miner knows that some barriers are indispensable for the safety of the mines; the report also overlooks the fact that power to have unnecessary barriers removed is given under the Mines (Working Facilities and Support) Act 1923, but so far not a single application for the removal of barriers under this Act has yet been made, which shows that the evil, if it exists at all, is certainly not a very pressing one.

The method suggested for the purchase of royalties is to divide all minerals into three classes, those which are known to exist and are actually under lease, those the existence of which is highly probable although they are not actually under lease, and those as to the existence of which nothing definite is known. It is proposed to deal forthwith only with the first named of these, and that they should be purchased for bonds issued by the Treasury, bearing interest, the rate of which the report conveniently omits to give. It is stated, though no basis of calculation is given, that the actual value of these minerals is approximately 70,000,000*l.* The total known coal reserves of Great Britain have been estimated at something like 150,000 million tons; assuming an average coal output of 300 million tons, the coal reserves would give a life of 500 years. For actuarial purposes this may be looked upon as a perpetuity, and the calculation in this way simplified. The amount of royalties paid on coal in 1923 was 6,300,000*l.*, so that unless royalty owners are to be deprived of a portion of their income, these bonds ought to bear 9 per cent. interest. These points are not considered in the report.

The second suggestion, which again is by no means fully worked out, is to appoint a series of bodies which are apparently to take a sort of paternal consultative interest in the mining industry. It is proposed to have three bodies, a National Mining Council to deal with the industry as a whole, District Boards for dealing with questions in each individual district, and Pit Committees to be "established in connexion with every pit, to consist of equal numbers representing the management and the workers." The report does not make it clear whether "pit" committee is meant or not. There are individual colliery companies having a dozen different pits; is it suggested that there shall be such a committee for each one of these pits? The idea of pit committees was decisively rejected by both the miners and the mine owners, and rightly so. The first essential for the safe and economic administration of a colliery is strict discipline throughout the pit, and it is obvious that there would be an end of such discipline if every petty question that arose had to be referred to a pit committee, while practical men do not need to be told that, in everyday colliery working, problems arise which must be dealt with on the spot and cannot be left to stand over

for discussion in a fortnight's time by the pit committee. District boards would probably do no harm, and a National Mining Council would probably be quite useful. Indeed, something approximating to this already exists in the Advisory Committee of the Mines Department.

A detailed discussion of all the statements in this report would demand far more space than is here available; the reader not versed in colliery matters should, however, be warned not to take all that he finds here as gospel truth, an unfairly coloured picture being presented in many cases, Thus to take one example, a number of photographs of miners' houses are shown, obviously with the intention of exciting the reader's sympathy. Three of these are of a block of cottages at Leadgate in Co. Durham. As a matter of fact, these cottages are now being pulled down by the colliery company which owns them in order to be replaced by more modern accommodation; surely the writer of the report ought to have known this fact, and if he knew it he ought surely to have stated it! It is difficult to understand how any one who knows the miner at all can write such a sentence as this: "Habituated with the conditions he (the miner) is not impressed with the imminence of danger, but he is aware of it; it is at the back of his mind always and affects his outlook on life." The miner rarely thinks of danger when he goes to his daily work, and would probably feel deeply insulted if any one suggested to him that he did. A couple of Durham pitmen who had been called up to London to give evidence in connexion with a mining case were heard on their return to be congratulating each other on being once again safe down the pit and away from the dangers of the London streets, and this represents the true attitude of the miner towards his daily occupation. As a matter of fact, their estimate of comparative danger was not really so far off the mark, seeing that there were *two-and-a-half times* as many fatal accidents (in 1922) in the streets as there were in the collieries of Great Britain. Great play is usually made in the discussion of coal mining, especially by those who are ignorant of the subject, with the dangers supposed to attend this work. It is unquestionably one of the more dangerous occupations, but its dangers are immensely exaggerated, and it may be hoped that the above simple statement of fact may help to put the problem in its proper perspective.

It need scarcely be said that there is only one real remedy for the difficulties with which the coal industry is struggling to-day, and that one, being unpalatable, as many salutary remedies are, is never mentioned in the report. It is summed up in the two words "MORE WORK."

H. LOUIS.

Theories of Growth and Senescence.

The Chemical Basis of Growth and Senescence. By Prof. T. Brailsford Robertson. (Monographs on Experimental Biology.) Pp. viii + 389. (Philadelphia and London: J. B. Lippincott Co., 1923.) *12s. 6d.* net.

THE physicist who theorises is more fortunate than the biologist. He may elaborate theoretical considerations for the whole of his life and still be talking sense at the end of it. It is hard for the biologist to theorise for five minutes without talking nonsense. Yet biologists, in spite of all the warnings of the past, find the theoretical impulse irresistible, and sometimes it is useful for them to give way to it. Not that their theories are likely to be true, but that they usually raise such acute opposition on the part of other biologists that the others devise experiments to refute them, and much valuable information is obtained. Not all theories have this salutary effect. Some act as intellectual soporifics providing attractive names, the frequent repetition of which hypnotises the hearers and stops all further inquiry. Of all the words that possess this "virtus dormitiva," there has been none greater than Weismann's "germ plasm." The "germ plasm," so far as we understand it, is a hypothetical substance with magical properties, which exists in living cells and enables them to divide. Some of it is infinitely divisible, and the possessors of this sort are germ cells; some of it resembles ordinary matter in being finitely divisible, and cells that possess this sort are somatic cells. Perhaps this statement is erroneous and the theory is not quite so bad really, but if so the difference is too subtle to have been grasped by its adherents or opponents.

Prof. Robertson's own theories are of the beneficent type just mentioned, but he has the misfortune to be haunted by the germ plasm, and at times the incubus is demoralising. The main theory which he advocates in this book is definite and capable of being put to experimental test. If it does not agree with all the facts, that is not surprising in the present state of knowledge. We may legitimately applaud Prof. Robertson for having found a theory which accounts for any of the facts, without therefore being expected to believe in it or to refrain from criticising it.

The fundamental facts on which the theory is based are, in brief, that the rate of growth of animals and plants follows a logarithmic formula that is the formula for the progress of an autocatalysed chemical reaction. Among the mammalia three growth cycles can be distinguished. Where, as in man, the cycles are definitely separated, the formulæ for each cycle show excellent agreement with the average curves of growth. In

some animals the cycles overlap and the results are therefore not so clear cut. On the assumption that growth is essentially an autocatalysed reaction, or rather that a reaction of this kind regulates its rate of progress, and assuming also that the autocatalyst concerned has certain special properties, the author proceeds to explain a large number of facts concerning differentiation of structure, regeneration, senescence, and so on. Let us first consider the significance of the growth curve itself.

The rate of growth of an organism, measured as increase in mass per unit time, first of all increases and then diminishes, giving a symmetrical S-shaped curve. This curve might be obtained either if we had an autocatalysed monomolecular reaction which came to a stop by the exhaustion of the material undergoing change, or if the reaction was reversible with both forward and backward reaction behaving as monomolecular, while the material supplying the forward reaction was maintained at a constant concentration. The second alternative is the one Prof. Robertson considers most probable, because in most organisms the supply of nutrient material for the cells is kept constant and the growth of animals certainly does not come to a stop at maturity for lack of nourishment. From the chemical point of view, there are two chief criticisms to be made to this theory. In the first place, it appears to be assumed that the reactions concerned in growth are all going on in homogeneous solution; an assumption that is not at all probable. The materials used for cell synthesis are certainly in aqueous solution, but some at least of the final products are not.

To this criticism Prof. Robertson would probably reply that whatever the nature of other chemical reactions concerned with growth, the particular one he is interested in occurs in homogeneous solution. Indeed, for the purposes of his theory he assumes that the autocatalyst itself, which must be a synthetic product, is diffusible and can pass from the cells to the body fluids, and therefore is likely to be in solution. If this be so, there is a further and more damaging argument to bring up.

All known processes of synthesis of organic cell constituents from organic food materials are processes of "condensation"; they consist in the elimination of the elements of water from between two or more molecules; and the reverse process is a hydrolysis. According to Prof. Robertson's own statement (p. 14) his autocatalysed reaction is likely to be of this type, because the only reverse reactions that could behave as monomolecular are oxidations and hydrolyses. As the animal body does not synthesise by reduction, the reactions must consist of condensation and hydrolysis respectively. On his view, however, they must go on in aqueous solution. The chief cell constituents, proteins, polysaccharides, fats and lipins, can all be shown to be unstable in the presence of water at the reaction of living tissues. The position of equilibrium is one of almost complete hydrolysis; this can be demonstrated by the action of the common hydrolysing enzymes. Therefore, cell synthesis must either take place in a non-aqueous medium, or else by some process not reproducible in the laboratory that carries a reaction away from the equilibrium position, against the thermodynamic gradient as it were. In either case the simple laws of catalysis in homogeneous solution are not applicable.

It is possible to imagine some soluble diffusible material being produced as a by-product of cell synthesis and acting as a catalyst of further synthesis; but it is almost impossible to see how such a substance could control the rate of growth in the way that Prof. Robertson supposes. What plausibility his hypothesis possesses at first sight, vanishes when any attempt is made to describe in detail from the physical point of view how an autocatalyst of growth would operate.

The autocatalyst of growth is supposed to be present in the body fluids, and its concentration there is supposed, among other factors, to regulate the rate of growth, accelerating it at first, and later, as it accumulates, bringing growth to an end. If this be the case, then blood from an adult animal ought to stop the growth of the tissues of a growing animal, and repeated bleeding of an adult animal with replacement of the blood by washed blood corpuscles in a suitable artificial medium might be expected to start growth again. Recent experiments by Carrel and Ebeling (*C.R. Soc. Biol.*, 1924, vol. 90, p. 170) suggest that the blood of young and of old animals differs in some such way, though the results are not exactly what Prof. Robertson's theory would lead us to expect. Moreover, if the theory is correct, it must be supposed that the placental membranes alone among tissues are impermeable to the autocatalyst, otherwise the mammalian embryo would never grow.

The evidence that the autocatalyst is soluble and diffusible is based, not upon any evidence from the higher animals, but solely on studies of infusoria, bacteria, and yeasts. In cultivating these organisms, it has frequently been observed that multiplication is stimulated by some dissolved substance which results from the presence of other organisms. (It is a pity that in this connexion Prof. Robertson makes no reference to the important work of Dr. E. J. Allen on the growth of marine algæ (Jour. Marine Biol. Assoc., vol. 10, 1914, p. 417).) The growth-stimulating substance appears to be common to several different types

of organism, but it is rather rash to assume on this account alone that an exact parallel can be drawn between the culture medium in which infusion organisms live and the body fluids of the higher animals.

There is no direct evidence on this point as to the higher animals, but some indirect evidence that goes strongly against this assumption. In their powers of chemical synthesis, living things seem to fall into three well-marked groups—the green plants, the "infusion organisms," and the higher animals. At the one extreme the green plants can synthesise all their body material from inorganic sources; at the other the higher animals, who have specialised in a different direction, have very largely delegated the business of synthetic organic chemistry to humbler creatures on whom they feed. The mammalia, for example, cannot synthesise the benzene or indole ring, but have to get them ready made in their food. The infusion organisms, such as yeasts, ciliate protozoa, and probably bacteria, moulds and other saprophytic plants, occupy an intermediate position rather nearer to the green plants than to the higher animals. They cannot live without ready formed organic material, as the green plants can, but they only need comparatively simple carbon compounds. Ciliate protozoa, as Prof. R. A. Peters has shown, besides inorganic salts, need only ammonia and an organic substance, such as lactic acid or glycerol, with a chain of three carbon atoms (*Jour. Physiol.*, vol. 55, 1921, p. 1). When the chemical processes underlying processes of growth are so different in the two groups, sweeping analogies appear to be out of place.

Prof. Robertson embodies in his theory certain subsidiary hypotheses, namely: (1) That growth is regulated by the cell nucleus in which the autocatalyst is found; (2) that it is only during mitosis that the autocatalyst escapes into the cytoplasm and body fluids; (3) that, in any given cell, division is regulated by the relative volumes of nucleus and cytoplasm; (4) that in the life-history of somatic cells there is a progressive change, a process of senescence, whereby the nuclear-cytoplasmic ratio at which division can take place gets smaller and smaller. The last change is supposed to be irreversible, and it is there that the trail of the germ plasm becomes evident. These hypotheses are, to say the least, not very firmly grounded on fact, and it is doubtful whether they increase or diminish the plausibility of the theory as a whole. They do, however, enable the author to give a detailed, if fanciful, explanation of the process of senescence and of phenomena such as the growth of cancer cells.

Leaving these questions aside, let us consider how the author deals with the facts of regeneration of lost or injured parts, for they are likely to prove crucial for any theory which partakes of Weismannism. Although there is considerable discussion about regeneration in the book, it is not easy to find a precise statement as to how the process is supposed to come about, but we get some information on p. 264. The view apparently is that in the adult organism cell division stops because of the accumulation of autocatalyst, but the stoppage is only relative to a given concentration of nutrient materials, so that anything which raises the concentration of nutrient material may start cell division going again. Injury is supposed, by removing competing cells, to cause a local increase of nutrient material, which acts as the stimulus for proliferation. Once the cells have started dividing, the rest of the process is explained in terms of nuclear-cytoplasmic ratios.

This part of the question need not concern us at present, except to point out that regeneration must, on Prof. Robertson's theory, be an irreversible process of senescence and therefore not capable of indefinite repetition. The really startling part of the theory is the suggestion that it is a local increase of nutrient material which first stimulates growth after injury. It must be confessed that no alternative theory is forthcoming, but one is not compelled to accept a false theory because there is no other to put in its place. When a lizard drops its tail there cannot be more than a momentary increase in the nutrient materials in the blood and body fluids, and what increase there may be will be quickly equalised all over the body. Suppose there is an increase that provides the stimulus to cell division, why does growth take place only at the stump and not throughout the whole of the animal?

The regeneration of a lost part is not the result of simple division of the functional cells *in situ*, but is the work of special cells which are in appearance embryonic. These cells appear to arise by de-differentiation of some of the cells of the region of growth. Thus it is found that the lizard's tail is regenerated by embryonic cells in the stump which persist at the growing end, until a tail which is functionally equivalent to the original has been produced. But structurally the new tail is not altogether similar. Bone is not regenerated, but cartilage takes its place and there are no new nerve cells. The new tail is innervated by nerve fibres growing out from some of the intact segments of the spinal cord. (See Dr. C. Powell White, British Assoc. Report, 1915, p. 472; more detailed information is in course of publication by the same author.) Another fact to be kept in mind is that many of the invertebrates can regenerate lost parts an indefinite number of times.

These facts show that the ordinary progression from youth to age can be reversed under certain conditions by some of the somatic cells. Immortality and rejuvenation are not a prerogative of the germ cells only. Somatic cells can, in many cases, take on the functions of germ cells by giving up their special function and reverting to a younger type. This fact has been notorious among the green plants, but it is also evident among the animals, even among the vertebrates. Any remnant of the germ plasm theory, however attenuated, is directly contradicted by these facts. One seems to be driven to take up some sort of position akin to Prof. C. M. Child's, who considers growth, senescence, and rejuvenescence in terms of the metabolic activity of the cells and not in terms of their visible structure or of hypothetical invisible components. One of the defects of Prof. Robertson's book is that he never once mentions Child's theory though referring several times to Child's experiments. In politics it may be often advisable to treat opponents with silent contempt, but men of science are expected to demonstrate the falsity of other theories before establishing their own.

Unworkable as Prof. Robertson's theory is in its present state, it has the merit of emphasising certain important facts which have got to be explained somehow or other. Apart from germ plasm complications, which are really extraneous to the main part of his views, the definiteness of the theory that makes it possible to subject it to experimental test is a great merit.

There is one final point of criticism that is perhaps worth making, though it concerns something outside the author's main line of argument. In the final chapter, in which general questions of evolution are discussed, the statement that variation always takes place by loss of characters reappears once again. It is quite true that under domestication the vast majority of heritable variations that have been observed, both in animals and plants, consist of the loss of a Mendelian factor. But it is also true that the conditions of domestication are physiologically peculiar and that the observed variations do not resemble the type of difference that normally distinguishes wild species from one another. Finally, there are a few cases among domestic animals that cannot be attributed to any cause other than the gain of a Mendelian factor: the most familiar of these are the White Leghorn plumage, and the Rose and Pea Comb among fowls. These are all dominant to the wild type, which in this species can be identified. That variation by gain of Mendelian factors occurs but rarely is no reason for denying its existence.

A. D. R.

Rockets to reach Planetary Space.

Die Rakete zu den Planetenräumen. Von Hermann Oberth. Pp. 92+2 Tafeln. (München und Berlin: R. Oldenbourg, 1923.) 1*s.* 6*d.*

THE prospect of propelling a body from our earth to one of the heavenly bodies, notably the moon, has excited certain types of individuals for some time, and many romances have been built up round the idea. Scientific attention has been given to the matter in recent years, and in particular Prof. Goddard, of Clark University, in the United States, has examined the question theoretically and experimentally. His plan is to send a rocket to the moon, more or less as suggested by Jules Verne, with the important difference that the rocket is not to be left to the mercies of air resistance and gravitational forces, but is to be propelled continuously by means of firing successive charges of smokeless nitrocellulose. Herr Oberth claims to have obtained the results given in the present volume quite independently of Prof. Goddard. He says that he commenced working at the problem in 1907, and that the main ideas were evolved in 1909: the calculations and proposals of this book were made during the years 1920–22.

Herr Oberth is more ambitious than Prof. Goddard: his object is to obtain sufficient financial support to be able to send off a rocket large enough to hold human beings. For fuel he suggests liquid hydrogen and a mixture of water and alcohol, the liberated gases escaping through small holes at the back of the rocket, and thus forcing the rocket forwards. He calculates that an initial speed of 11 km./sec. would suffice for getting out of the earth's field of gravitation. The calculations are simplified by introducing the assumption that while the rocket is still in the earth's atmosphere, the fuel is used at such a rate as to give at each instant what is practically the "limiting velocity" at the instant.

The author discusses the theoretical as well as the chemical, physical, and even physiological aspects of such a venture. He examines the economic possibilities, but he does not appear to be very sanguine about his scheme being carried out. He estimates that a rocket for two persons would weigh 400 tons, would need 25 tons of alcohol and 4 tons of liquid hydrogen, and would require an initial outlay of 50,000*l.* on the basis of pre-War prices.

A voyage to the moon would be an attractive trip to many adventurous spirits; and in these days of unprecedented achievements one cannot venture to suggest that even Herr Oberth's ambitious scheme may not be realised before the human race is extinct.

S. B.

Our Bookshelf.

Handbuch der Zoologie: eine Naturgeschichte der Stämme des Tierreiches. Begründet von Prof. Dr. Willy Kükenthal. Herausgegeben von Dr. Thilo Krumbach. Band 1: Protozoa, Porifera, Coelenterata, Mesozoa. Lieferung 2. Pp. 193-416. 10.50 marks. Lieferung 3. Pp. 417-512. 4.50 marks. (Berlin und Leipzig: Walther de Gruyter und Co., 1923–1924.)

PROF. M. HARTMANN, who is responsible for the account of the Sporozoa, has separated the Amœbosporidia (Neosporidia)—with its two subclasses Cnidosporidia and Acnidosporidia—as one of the six main classes of Protozoa, so that the class Sporozoa now includes only the Gregarinida, Coccidia, and Hæmosporidia. The morphology and life history of the principal members of these orders are carefully described, an outline classification showing the position of the chief genera is given, and a list of the more important memoirs on the subject is appended. The value of the many excellent figures would have been enhanced if the magnifications had been indicated; without these the student is apt to form an exaggerated idea of the size of many of these organisms.

The Ciliophora and the Suctoria are described by Prof. L. Rhumbler.

Prof. E. Hentschel contributes the chapter on Porifera, treated in five orders—Calcarea, Triaxonida (Hexactinellida), Tetraxonida, Cornacuspongia, and Dendroceratida. To compress the account of this large phylum into 100 pages necessitates strict selection of the material available, and no two authors would agree as to the matters to be included, but we would suggest that in the account of reproduction, reference should have been made to the observations of Dendy and Gatenby on the origin of oogonia from collar cells in Grantia, and to Gatenby's account of the peculiar method of transportation of the sperm to the egg.

The third Lieferung is devoted to accounts of the Hydroida and Trachylina by Dr. Hj. Broch and of the Siphonophora (part only) by Dr. Fanny Moser. Dr. Broch gives two maps showing respectively the distribution of some of the marine hydroids and of the Trachylina and freshwater medusæ. The occurrence of Limnocnida in India is not noted here or in the text, though reference is given in the literature list to Annandale's papers on this medusa.

The "Handbuch" is trustworthy, clear, and orderly in its method, and is adequately illustrated with good figures. It provides sound information on the morphology, systematics, development, and ecology; histology, however, is only briefly considered.

The Brain and Golf: Some Hints for Golfers from Modern Mental Science. By C. W. Bailey; and a chapter on Theory and Practice by Bernard Darwin. Pp. xv+96. (London: Mills and Boon, Ltd., 1924.) 2*s.* 6*d.* net.

THE theories of a science often appear to students quite intelligible until it becomes necessary to express them in terms of practical problems; the question of application is always difficult no less in science than in ethics. This little book comes as a welcome relief from the wearisome mass of ill-assorted oddments frequently dignified by the name of applied psychology. It is an amusing, light-hearted account of the laws of physiology and pyschology in so far as they apply to the playing of golf. The game is treated with serious humour; the psychology is not merely appended but is used to explain, to illustrate, to vitalise, the game. The psychologist familiar with the principles and accustomed to applying them in certain fields will find them vivified by their new setting. The golfer will find reasons for many inexplicable troubles and will be taught why such and such a habit is desirable or otherwise; he will be saved much unnecessary depression if he really grasps the laws of habit as here explained, and in particular the reference to the "plateau of habit."

The writer might with advantage have invoked still further the aid of the newer psychology and discussed types of golfers as illustrated by Jung's psychological types, and the revelation that is made of the golfer's own character by his behaviour to superiors, equals, and inferiors on the links. The various "complexes" concerned with the "ego" are more evident than the writer shows, for it is in games that people usually display their fundamental characteristics. A writer of Mr. Bailey's capacity might make a fascinating study of this aspect.

The book can be heartily recommended to all intelligent golfers, to students of psychology, and above all, to those concerned with the application of psychology to education.

A Bibliography of Eugenics. By Prof. Samuel J. Holmes. (University of California Publications in Zoology, vol. 25.) Pp. iv+514. (Berkeley, Cal.: University of California Press, 1924.) 5 dollars.

THE literature of eugenics has grown in a most haphazard way. While the number of scientific journals primarily devoted to the subject is a limited one, yet the medical journals teem with papers having a eugenical bearing, and a widely scattered multitude of books and journals contain information biological, anthropological, psychological, and sociological, which the eugenist must needs consider. There has also been a great amount of popular and semi-popular writing on this subject from widely differing points of view.

It is obviously impracticable to bring an index of all this literature within the covers of one volume. Prof. Holmes has attempted the somewhat more limited task of producing a bibliography which would include all the main sources and items of eugenical literature. In doing so he has produced a volume which will be of great service, not only to students of eugenics but also to all who are concerned with the biological evolution of man. That the field is a modern one is shown by the fact that the great majority of the titles are dated later than 1900, and very few are so early as 1860.

The bibliography is arranged under about 40 different headings, ranging through such topics as heredity and evolution, genealogy, inheritance of deafness, the hereditary factor in crime, the birth rate, the racial influence of religion, the sex ratio, consanguinity, and the selective influence of war. Titles on the inheritance of feeble-mindedness occupy 12 pages of the bibliography. One would like to have seen extended

the sections on the heredity of human traits and human defects. Many additions might have been made here even without encroaching on the medical literature. But although completeness is obviously impossible, and the topics of the author's special interest are naturally emphasised, yet this work will occupy a useful place as a first book of reference on any topic connected with eugenics.

The Road-Books and Itineraries of Great Britain, 1570 to 1850: a Catalogue with an Introduction and a Bibliography. By Sir Herbert George Fordham. Pp. xvi+72. (Cambridge: At the University Press, 1924.) 7s. 6d. net.

ROAD-BOOKS and itineraries are dear to the heart of the collector, but, unlike most collectors' books, they have a wider interest, and their value to the antiquarian and the topographer is considerable. Many, however, and especially the earlier, are rare and difficult to obtain, and Sir H. G. Fordham's bibliography, which is a revised and amplified reprint of a paper published in the Transactions of the Bibliographical Society in 1916, will be of considerable assistance to those who wish to make use of the material to be found in these guide-books of our ancestors. In this catalogue, road-books are taken to include only such as set out individual roads, with distances and stages all grouped together as a book or atlas, and prepared for the use of travellers. They may vary from a mere enumeration of stages to a full descriptive text. The earliest entry is John Leland's Itinerary published in or about 1535–1543. In the later part of the sixteenth century tables of the principal British highways based on the old British mile of 1500 Roman paces, equivalent to 2428 statute yards, were associated with lists of fairs for commercial purposes. Tables of highways of a similar type were published by Charles Étienne in 1552, while in Germany the earliest would appear to be a publication of 1597, containing 187 roads on the Continent and eleven from London to various parts of England and Wales.

Principles of Electroplating and Electroforming (Electrotyping). By William Blum and George B. Hogaboom. Pp. xii+356. (London: McGraw-Hill Publishing Co., Ltd., 1924.) 20s. net.

THE work under notice has been written mainly to help those employed in the industry to understand and apply results which have been obtained in research laboratories. The authors have taken a leading part in the investigation of electrotyping and electroplating processes at the U.S. Bureau of Standards. They divide electrodeposition into four main fields: Electrorefining, electrowinning, electroplating, and electroforming. The last is a new word and is defined as "the production or reproduction of articles by electrodeposition." It is suggested as a substitute for the archaic word "galvanoplasty" which is still sometimes found in text-books.

The very extensive use of iron and steel for constructional purposes, and the fact that they rust when exposed to air, has led to numerous investigations as to the causes and methods of preventing corrosion. Many of the investigations were carried out during the War and the general results obtained were summarised in Circular 80 of the Bureau of Standards. It appears that of all commercial metallic coatings, zinc is much the best protector. It is very desirable that zinc plating should be applied much more extensively in industry than it is at present. Unfortunately zinc coatings have not a pleasing appearance. When a bright metallic lustre is essential, nickel is superior to any other material. This book contains a great many valuable hints and can be recommended to those technically interested in the subject.

The Growth of Civilization. By W. J. Perry. Pp. viii+224+8 maps. (London: Methuen and Co., Ltd., 1924.) 6s. net.

IN this volume Mr. Perry restates in a more popular and abbreviated form the arguments put forward at length in his earlier works, "The Megalithic Culture of Indonesia" and "The Children of the Sun," for the diffusion of culture from one common centre, namely Egypt. It forms a companion volume to his book on "The Origin of Magic and Religion," which indeed is essential for the complete grasp of the argument here stated, as in the latter he expounded the theory of the magical influence of gold and other substances which supplied the motive for the wanderings of the people by whom the "archaic culture" was carried to various parts of the world. This book is, however, not merely a condensation of earlier work. It embodies much evidence not previously considered, especially in the later chapters, in which he deals with the coming of the warriors by whom the archaic civilisation was overthrown in various parts of the world, and discusses the theory that traditions of royal descent from deities derive from contact with Mediterranean culture and ultimately from Egypt. Mr. Perry's statement of what is undoubtedly a difficult and highly controversial case, leaves little to be desired in point of lucidity.

Faune de France. 7: *Pycnogonides.* Par Prof. E.-L. Bouvier. (Fédération française des Sociétés de Sciences naturelles: Office central de Faunistique.) Pp. 70. (Paris: Paul Lechevalier, 1923.) 8 francs.

PROF. BOUVIER points out in his introduction that the pycnogonids of the French fauna have never been studied in systematic fashion. There are memoirs by Hoek on the species found at Roscoff, by Grube on those of S. Malo, and a recent account by Cuénot of his observations on pycnogonids at Arcachon. The author has turned to G. O. Sars' well-known monograph and to that of Dohrn for further information, and from these and from Hoek's work he has borrowed most of the figures used in the present volume. He gives an account of the external morphology, the internal anatomy, and the development and biology, and in a brief discussion of the affinities states his view that the pycnogonids are arachnids. In a short reference to the forms with five pairs of legs, *e.g.* Decalopoda, he concludes that these are primitive relatively to Colossendeis. Keys are given for the orders, families, genera, and species, and with the help of these and the clear illustrations the determination of any given specimen is fairly easy. This concise memoir will be very useful to collectors on the shores of Great Britain who have an interest in this group.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Mass Spectra of Zirconium and some other Elements.

AFTER repeated failures I have now succeeded in observing the mass rays of zirconium. Their detection is only possible under very favourable conditions with the most sensitive schumannised plates. Zirconium gives mass lines 90, 92, 94 and a doubtful one at (96), with relative intensities, very roughly, 10, 2, 4, (1) respectively. The masses of the first three can be determined with unusually high accuracy, owing to the incidental presence among them of a faint doublet 93, 95 due to CBr. There is no appearance of asymmetry in the spacing, so that the masses of the isotopes of zirconium must be very closely integral with those of bromine; that is to say, less than whole numbers by about one-tenth of a unit. The atomic weight may therefore be roughly estimated as 91·4 or 91·2, according to whether the mass number 96 is included as an isotope or not.

Successful mass spectra have been obtained with cerium (at. wt. 140·25), which indicate that it consists of a strong component 140 and a weak companion 142. Further experiments with neodymium (at. wt. 144·27) establish its principal isotopes as 142, 144, 146, with a possible (145).

Continuous work with anode mixtures not containing iodide has reduced the intensity of the iodine line sufficiently to warrant a further search for light isotopes of barium. Its principal line 138 has been obtained of great intensity, but there is no trace whatever of any mass number less than 136. There is some evidence of a faint component at 136, and, since the great intensity of the 138 line makes resolution impossible, 137 may also be present. It seems quite certain, however, that, even if both exist, they can only do so in quantity quite inadequate to account for the low value of the atomic weight (137·37) at present in use.

Incidentally, during this work I have obtained mass spectra of silicon under conditions affording satisfactory confirmation of the presence of Si^{30}, previously in some doubt. Its line is a little less intense than that of Si^{29}, in excellent agreement with Mulliken's observations on band spectra (NATURE, March 22 and April 5, pp. 423, 489).

It will be noticed that the above results are on the whole in fair agreement with the predictions made by A. S. Russell.

F. W. ASTON.

Cavendish Laboratory, Cambridge,
August 8.

The Zeeman Effect in Strong Magnetic Fields.

IN a recent paper (Proc. Roy. Soc. A, vol. 105, p. 691, 1924), one of us has given an account of a method for the production of intense magnetic fields, with the limitation, however, that the field only lasts for a time of the order of 1/100th sec. We are now investigating the Zeeman effect in these intense fields These fields allow the use of a quartz spectrograph in place of the usual large concave grating or interferometer, etc.

For the source of light, we have been using a spark produced in a special way from a large high tension condenser battery, and the intensity is sufficient for one spark to produce a spectrum photograph, while most of the emission lines remain quite sharp. The spark takes place in a coil of 5 mm. internal diameter in which the field is produced, and the spark and the current in the coil are timed to occur together.

We have so far investigated mainly the "longitudinal" Zeeman effect (observation in the direction of the lines of force) in fields of about 130,000 gauss as being technically easier than the "transverse" effect. The accompanying photograph (Fig. 1), enlarged from the original six times, shows one of the results. The lines are the first members of the principal series of doublets of ionised calcium (Ca II) and of the sharp series of doublets of aluminium. It is feared, however, that the latter may not show clearly in the reproduction, though they are quite obvious in the original. The magnetic separation is about 3 Å.U.

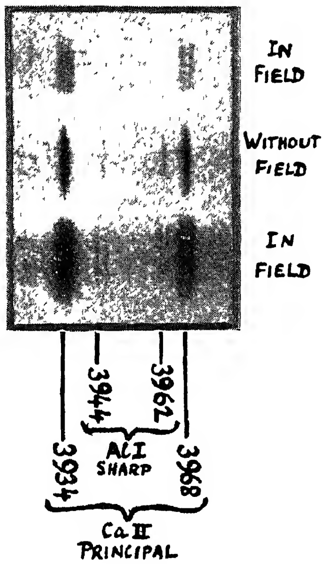


FIG. 1.

Generally speaking, the results so far obtained on lines of various elements indicate that the magnetic splitting is, except for the larger scale, identical with that obtained in ordinary cases. We have, however, observed some interesting cases of the Paschen-Back effect, partial and complete. We may mention in particular the case of the Be group 2650, given by Paschen-Götze as the *p*, *p′* group of Be, and as consisting of six extremely close lines. We have found that this group taken as a whole shows the normal Zeeman effect.

We have observed some interesting cases of lines appearing strongly in the spectrum taken in the field which do not appear in the comparison spectrum, and other cases of lines disappearing in the field. A further effect observed is that the lines produced in the field are shifted towards the red by varying amounts. It is possible that this is a kind of pressure effect, due to the production of the spark in the field, and to investigate the matter further, and for other reasons, we hope shortly to deal with absorption spectra. We have also a project for the production of still higher fields (probably up to 250,000 gauss) by cooling the coil with liquid air in order to be able to use more turns in a coil of given resistance.

P. KAPITZA.
H. W. B. SKINNER.

Cavendish Laboratory, Cambridge,
July 20.

Biology and Sociology.

I SHOULD like to direct attention to a point connected with the above topic which Dr. Malinowski does not mention in his article in NATURE, July 19.

What is of importance is not the transference of ready-made biological theories to the field of sociology, but rather that the problems of cultural evolution should be approached from the same detached and objective point of view as that of the biologist. Natural selection, for example, can be strictly said to operate

in the latter case only where competition may result in the extinction rather than the modification of whole groups, where, alone, a particular cultural element has a definite survival value in the biological sense. But it is none the less true that the process of what may be termed "bio-economic adjustment" is still everywhere proceeding, and the character of the culture-milieu of a particular society at any moment must be regarded, in the main, as a reflex of the whole complex of primary and secondary environmental factors which operate upon the group-members, in addition, usually, to a number of functionless or residual characters of historical interest, which were evolved in relation to anterior conditions.

Perhaps the most important lesson that sociology can learn from biology is the fundamental distinction between the purely *historical* problem in evolution and the question of the *machinery of variation*, a distinction which, in sociology, is unfortunately often disregarded. We desire to know, not only what has happened, but also how it happened, and why it happened only in this particular time and circumstance. It is too often tacitly assumed, especially by the "new" anthropologists, that to point out a possible derivative origin of a certain cultural element is a sufficient explanation of its existence in a particular society. The conditions which govern *assimilation* are of equal if not greater importance. To give a homely example: if Dr. Malinowski were to appear in his class-room wearing a Malayan kris, this would introduce a new cultural element into British academic life; but it is very doubtful if it would afford any research problem for the future historical sociologist.

Moreover, just as in biology the problem of variation is being most usefully attacked by concentrating upon small definite changes in organic characters, which are actually taking place now under observational conditions, rather than upon the historical background of evolution: so we must hope to make most progress in the study of cultural variation by observing and correlating small specific changes in contemporary civilisation, rather than the character of past or primitive societies. It is more useful to analyse carefully the conditions which are associated with the incidence of prohibition or divorce reform than to speculate about the origin of totemism.

To contrast the instinctive and physiological dispositions of an insect colony with the "culture" of human society does not take us very far, unless we have a clear understanding of the factors upon which cultural changes depend. This latter question cannot be discussed here, but it may be pointed out that whereas the *limiting conditions* of social changes are bio-economic, the machinery of variation is psychological. The psychological factors involved are partly rational, but mainly in the nature of specific emotional dispositions in relation to particular social facts. Dr. Malinowski's suggestion that these definite but variable ethical and æsthetic attitudes are due to the secondary modification of primary instincts does not help very much. To say, for example, that humanitarian sentiment is a secondary derivative of the parental instinct does not explain why the *average* emotional reaction of successive generations of the same society towards specific questions (*e.g.* slavery, criminal punishment) should often be so markedly different. From the point of view of cultural evolution, it is the exact character, sequence, and correlations of these specific reactions which is of principal importance.

C. W. SOAL.

Scratton Lodge, Prittlewell, Essex.

IN the article referred to by Mr. Soal, I have tried, on a parallel between an insect aggregate and human society, to trace the breach of continuity between biology and the science of human culture, as well as to establish their points of contact. I have also criticised certain illegitimate attempts at transference of methods and concepts from the study of living organisms to that of culture and social organisation, notably the society-organism simile, the theory of "herd instinct," and certain crude applications of Darwinism in sociology. In the above letter it is suggested, obviously in criticism of the last-mentioned contention of mine, that I have neglected to discuss the applicability of natural selection to the study of human culture.

It is now a commonplace for any competent sociologist that natural selection, as we know it from biology, cannot in any way operate on human individuals within the community—and this is made clear to any one who reads my above-mentioned article. Nor can the principle be applied to any struggle or competition of groups within society. (For searching criticism, see J. Novicow, "La Critique du Darwinisme sociale," Paris, 1910, and III. Abteilung, "Die allgemeine biologische Soziologie," in P. Barth's "Die Philosophie der Geschichte als Soziologie," pp. 260-437, 4th ed., 1922.)

But there remains the question: Can natural selection or Darwinism in general be applied to varieties of the human species, to races, or to entire populations, or to types of human culture taken as a whole? Here also there is no new ground to break, for the "struggle of races" (Rassenkampf) has been used, abused, and rejected as a leading principle of social science, while laws of growth, culmination, and decay of nations and cultures have been constructed and demolished more than once. Again, what could be called "the struggle of cultures," the contact, mixture, and transmission of whole types of civilisation or elements thereof, is really the fundamental principle of the "new anthropology" mentioned by the above correspondent. How far the adherents of this school will succeed in explaining everything by this principle, or in constructing a new theory of universal advance by contact of cultures, remains to be seen. At present they are clearing the ground, amassing material, and working out particular questions.

Thus the problem which Mr. Soal recommends *en passant* to the attention of anthropologists is, as a matter of fact, the fundamental problem of the science of man, inspiring all the general theories and entering into all detailed work on concrete subjects. It is, of course, recognised to be so by all anthropologists who reflect on the aims of their science. So that generalities such as that "natural selection . . . can be strictly said to operate . . . where competition may result in the extinction rather than the modification of whole groups"; and again, about "bio-economic adjustment" or about "a reflex of the whole complex of primary and secondary environmental factors which operate on all the group members," etc., will be of little use even to those who can grasp their somewhat cryptic meaning.

I think it is obvious that in this connexion biology cannot help us very much, for natural selection, as we see it at work in the world of plants and animals, cannot be applied to the study of societies. Natural selection operates on individual organisms, directly at grips with their environment, competing with other creatures who need the same food, every individual struggling by its own efforts, pursuing its own ends, and having to rely on its own anatomical and physiological endowment. A human society is not an individual organism; it possesses no anatomical or physiological equipment, it has no biological aim or needs of its own. It exists only by its own members and for their benefit. The type, the aim, and the

value of its organisation and culture must be gauged by the manner in which it ministers to the wants of the individuals which constitute it. Here then are problems so absolutely foreign to the biological theory of natural selection as to preclude any borrowing by sociology from biology.

Mr. Soal's kind exhortation to anthropology that it should become "detached and objective," and that it should give up troubling about the "character of past or primitive societies," and study "prohibition or divorce reform" instead, will no doubt be humbly and hopefully received by other anthropologists as it is by the present writer; though I fear that my experience in discussions about problems touching liquor and sex seems to show that they do not lead to an "objective or detached" frame of mind. In the attempt to follow his advice, we might realise Mr. Soal's "homely example" of an anthropologist appearing "in his class-room wearing a Malayan kris," a tendency of which he seems to suspect me. I do not think there is any hope, either, that the science of primitive man should give up studying primitive man, any more than that astronomers should give up studying stars, when advised to turn their attention to turnips and potatoes, since this "is more useful."

BRONISLAW MALINOWSKI.

Department of Ethnology,
London School of Economics,
University of London.

Solubility of Phosphates in Relation to Hydrogen Ion Concentration.

WITHIN the last few years statements have appeared in various journals giving the P_H values at which certain salts yield precipitates upon being rendered less acid. Some of these also record the lower limit of acidity at which precipitation is said to be complete. It accordingly appeared to be of interest to determine the form of the solubility curve. This was done for certain phosphates, using samples purchased as pure and washed with distilled water repeatedly to remove traces of more soluble phosphates, etc. The determinations were made at air temperature, about 10-12° C., upon solutions cleared by the centrifuge, using the cœruleo-molybdate reaction of Denigès. Nine determinations were made upon a sample of tricalcic phosphate (B.P.), between P_H7·0 and P_H5·1, hydrochloric acid being used to increase the acidity.

Over this range the solubility increased from 114 to 786 parts per million. When P_H values are taken as ordinates (the higher values being at the bottom of the paper) and concentrations as abscissæ, the nine points give a curve which at first ascends steeply and then becomes more nearly parallel to the concentration axis; thus a small change in the P_H value is accompanied by a large change in solubility. Accordingly the precise P_H value at which a precipitate is first obtained depends on the concentration of the phosphate and precipitation is never absolutely complete with the pure salt, even at P_H7·0. The phosphates of strontium and of barium give curves which are qualitatively similar. The phosphate of magnesium is more soluble 450 p.p.m. at P_H7·7, and the curve rises somewhat less sharply at the start; it reaches the value 1233 p.p.m. at P_H5·8.

$CaHPO_4$ is much more soluble than $Ca_3(PO_4)_2$, and the solubility of the latter is increased if it contain any of the former as an impurity. $CaH_4(PO_4)_2$ was found to dissolve readily, a slight deposit only being left; this does not appear to be the original salt. The reaction given by the sample used was markedly acid, P_H3·6.

The phosphates of lead and zinc were found to be highly insoluble, lead only giving phosphate equivalent to 0·97 p.p.m. of P_2O_5 at P_H6·75 and zinc 1·11 at P_H6·85, nickel follows with 11·9 at P_H8·9. The readily hydrolysed ferrous and ferric phosphates appear to have solubility minima in the acid region, and the addition of alkali to bring the solutions to neutrality results in more phosphate becoming available in solution. These relations, being of importance in studies on plant nutrition, are being worked out, and it is hoped that the results may be published in more complete form within a year.

W. R. G. ATKINS.

Marine Biological Laboratory,
Plymouth, July 16.

The Phosphide Eutectic in Cast Iron.

THE accompanying photomicrograph (Fig. 1) shows the phosphide eutectic in a grey cast iron at 5000 diameters. This shows that the constituent which appears as dark markings at ×1000, and is still commonly described as iron carbide, is actually duplex, and in fact very similar to pearlite, consisting of alternate laminæ of iron carbide and iron.

FIG. 1.—Phosphide eutectic in cast iron. ×5000.

It is recognised from the research of Stead that there would be present the three constituents of the triple eutectic, namely, iron phosphide, iron carbide, and austenite, or their transition products. Thus the presence of laminated pearlite, from the transformation of austenite, is accounted for. The pearlite thus associated structurally within the phosphide masses may conceivably be richer (it probably is, but may even be poorer) in carbon content than obtains in the normal pearlite ratio, Fe_3C 21Fe. Prof. Desch,

to whom I have shown several similar photographs, confirms the foregoing explanation. The photograph was taken at 5000 diameters by means of the supermicroscope. F. Rogers.

5 Hicks Lane, Westbar, Sheffield.

"Bitumen" in Meteorites.

The statement that is currently repeated as to the existence of bitumen in meteorites does not bear examination. It is based on a number of investigations that were made between 1834 and 1885 on the alcohol- and ether-soluble material obtained by extracting meteoric matter, but no recent work appears to have been done to throw further light on the subject. The weights of the samples examined were so small that quantitative analyses are not very convincing, but an undoubted uniformity of results can be traced.

There has been obtained a hydrocarbon (possibly containing sulphur and oxygen), melting about 114° or 120° C., accompanied by free sulphur and graphite —and this is the material, present in an extraterrestrial body, that is quoted to-day as evidence for the inorganic origin of terrestrial petroleum.

The suggestion now made is, that the presence of the hydrocarbon is due to the action of water on carbide after the arrival of the meteorite on the earth. The evidence for this is the following:

1. Iron-nickel carbide is found in meteorites.
2. Water poured on to powdered meteorite causes the production of "an alliaceous odour."
3. Phosphide is also present.
4. The water that is usually found in meteorites is considered by authorities not to be original, but to have been taken up at some subsequent time.
5. Soluble carbon compounds have been stated to be completely removed by solvents without preliminary pulverisation of the meteorite sample; that is, they exist in cracks and pores which are just the positions into which water could percolate.
6. Solid hydrocarbons are formed by the action of water on carbides of metals of high valency. These carbides are actually present though in small quantities and not often; these hydrocarbons are also present in small quantities and not often.

This explanation, if correct, dissipates the present contradictory evidence of the presence of, on one hand:

(*a*) graphite, suggesting crystallisation from an iron magma;

(*b*) carbide and phosphide, suggesting high temperatures of formation;

(*c*) an outer skin, indicating the attainment of a high temperature on reaching the earth's atmosphere; and, on the other hand,

(*d*) of a hydrocarbon of low melting point, absolutely precluding the possibility of a high temperature after its formation. Percy Edwin Spielmann.

The Athenæum,
Pall Mall, S.W.1, August 6.

Comparison of Wave-lengths with a Fabry and Perot Étalon.

In the issue of Nature for June 28, p. 926, Prof. Robertson, discussing the "Comparison of Wavelengths with a Fabry and Perot Étalon," points out that for determining fractional orders of interference it is sufficient to measure only the linear diameters of the interference rings. This practice has been used extensively at Mount Wilson Observatory for ten years. It was described in Mount Wilson Contributions, No. 137, *Astrophysical Journal*, 46, 138, 1917, and No. 202, *Astrophysical Journal*, 53, 42, 1921, where full details will be found. It was shown that the method offers marked advantages, such as (1) reduction of labour, (2) smaller probable errors, (3) convenient numerical checks which diminish the chances of mistakes in computation.

It is unfortunate that, on account of the form in which Prof. Robertson expresses the idea of the method, he has committed, inadvertently no doubt, the error of deriving six values of the fractional order from only four observations, and in consequence he finds an incorrect result with too small a probable error.

It seems to me preferable to write the fundamental equation in the form

$$a = 1 - n + cd_n^2$$

where a is the fractional order, n is the number of the ring of diameter d_n, counting the innermost as the first, and c is a constant for all the rings of a given line, depending on the integral order of interference, the focal length of the projector, and the magnification in the spectrograph. It is evident that the two unknown quantities a and c may be evaluated if at least two diameters are measured, and that if q diameters are measured only $q-1$ independent values of a may be found.

In the practical use of the method for extended investigations, the constant c is derived from a combination of the measurements on many lines, and it becomes legitimate to obtain q independent values of a from q diameters measured on a given line.

Harold D. Babcock.

Mount Wilson Observatory,
Pasadena, California,
July 23.

A Substitute for the McLeod Gauge.

The results of our experiments do not confirm Mr. Fleuss's statements (Nature, July 5, p. 12). Even if the water vapour is always at a pressure less than its equilibrium vapour pressure at room temperature, the McLeod gauge reads low and usually inconsistently. The reason is, of course, to be found in the absorption of water by glass. Water vapour will condense on glass when its pressure is raised, even when the final pressure is no greater than 0·001 mm.; the amount that condenses increases with the time, so that the reading of the gauge depends on the rate at which the mercury is raised. All this is quite familiar to those who work with modern high vacuum apparatus; but Mr. Fleuss's statements, if unchallenged, might mislead some who are only beginning to acquire their experience.

Norman R. Campbell.
John W. Ryde.
Bernard P. Dudding.

Research Laboratories of the General
Electric Company, Ltd., Wembley,
July 28.

Life History of the Pearl Mussel.

Does any one know what happens to the pearl mussel (*Margaritana margaritifera*) between the glochidium falling off the trout, etc., and the big adult mussel? No one seems to have seen young individuals, and the ordinary specimens which are found are never less than about 3 inches long and must be several years old. I have lately had another vain hunt for young ones in the Herefordshire Wye, so far as it is accessible by paddling; presumably they live somewhere in deep water, and not in the shallows where the adults are. The revival of the pearl fishing in recent years may have led some one to work out the life history: its investigation might be a grateful occupation for summer holidays. A. E. Boycott.

17 Loom Lane, Radlett,
July 31.

A Hundred Years of Electrical Engineering.[1]

By Prof. G. W. O. HOWE.

IF any one event can be regarded as the birth of electrical engineering, it is surely the discovery by Faraday in 1821 of the principle of the electro-motor; that is, that a conductor carrying a current in a magnetic field experiences a force tending to move it. It is noteworthy that ten years elapsed before Faraday discovered, in 1831, the magneto-electric induction; that is, the principle of the dynamo. Four years later, Sturgeon added the commutator or "uniodirective discharger," as he called it, and in 1845 Cooke and Wheatstone used electromagnets, which Sturgeon had discovered in 1825, instead of permanent magnets. It was during the years 1865–1873 that the shunt and series self-excited dynamo, using a ring or drum armature and a commutator of many segments, finally evolved.

The early workers in the field do not appear to have realised the intimate connexion between the dynamo and the motor, for, although the principle was discovered by Lenz in 1838, it only appears to have become generally known about 1850 that the same machine could be used for either purpose. The principle underlying the whole modern development of electrical engineering, namely, the generation of electrical power by a dynamo, its transmission to a distant point, and its retransformation to mechanical power by an electric motor, appears to have evolved about 1873.

The development of the dynamo during the 'seventies and the simultaneous development of the incandescent lamp led to the general introduction of electric light during the 'eighties. Attempts to make incandescent electric lamps had been made so early as 1841, when de Moleyns patented one having a spiral platinum filament; and in 1847 Grove illuminated the lecture theatre of the Royal Institution with such lamps, the source of power being primary batteries; but it was not until 1878 that the commercial development of the incandescent electric lamp was begun by Edison and Swan.

One of the earliest complete house-lighting installations was put in by Kelvin in 1881. A Clerk gas-engine was used to drive a Siemens dynamo, a battery of Faure cells was fitted up, and every gas-light in his house and laboratory at Glasgow University was replaced by 16 candle-power Swan lamps for 85 volts. He had to design his own switches and fuses, etc., for such things were almost unknown.

For about twenty years the carbon-filament lamp held the field without a rival for interior illumination, and, although attempts were made to improve its efficiency by coating the filament with silicon, the plain carbon filament only gave way finally to the metal-filament lamp. One of the most interesting developments in the history of electric lighting was the Nernst lamp, which was introduced in 1897; the filament consisted of a mixture of zirconia and yttria, and not only had to be heated before it became conducting but also had to be connected in series with a ballast resistance in order that it might burn stably. The way in which these difficulties were surmounted and the lamp, complete with heater, ballast resistance, and automatic cut-out, put on the market in a compact form occupying little more space than the carbon-filament lamp was, in my opinion, a triumph of applied science and industrial research. The efficiency was about double that of the carbon lamp. About this time, however, a return was made to the long-neglected metal filament. The osmium lamp invented by Welsbach in 1898 was put on the market in 1902, to be followed two years later by the tantalum and tungsten lamps. The latter was greatly improved by the discovery in 1909 of the method of producing ductile tungsten and by the subsequent development of gas-filled lamps in which the filament can be run without undue volatilisation at such a temperature that the consumption is reduced in the larger sizes to 0·6 watt per mean spherical candle-power. This improvement of eight times as compared with the efficiency of the carbon-filament lamp has led to the gradual replacement of the arc lamp even for outdoor illumination. The arc lamp was introduced at about the same time as the carbon-filament lamp, the Avenue de l'Opéra having been lit with Jablochkoff candles in 1878. The open arc was developed during the 'eighties; the enclosed arc, giving long burning hours and thus reducing the cost of recarboning, was introduced in 1893, and the flame arc in 1899. During the first few years of this century the flame arc was brought to a high stage of development and the consumption brought down to about 0·25 watt per candle-power, but the necessity of frequent cleaning to prevent the reduction of efficiency by dirt, and the labour of recarboning, have led to its abandonment in favour of the less efficient filament lamp.

Before leaving the subject of electric lighting I would point out that it is remarkable that the first great application of electric power should have been for the production of electric light, since it is probably the least efficient of all its applications. The overall efficiency of a small power station supplying a lighting load and having therefore a very poor load factor would not be greater than about 6 per cent. from coal to switchboard, the steam-engine being, of course, the principal offender. Of the total power supplied to and radiated from a carbon-filament lamp not more than about 2 per cent. was radiated as light, so that the overall efficiency from coal to light was 2 per cent. of 6 per cent., which means that of every ton of coal burned at the power station with the object of producing light all but about 3 lb. was lost as heat at various stages of the transformation. Even now, with up-to-date steam plant and gas-filled lamps, the overall efficiency from coal to light is not equivalent to more than 40 to 60 lb. of coal out of each ton. The electrical engineer may derive a little comfort from the knowledge that the purely electrical links are the most efficient in the chain.

Whilst on the subject of efficiency I might point out that the difference between the prices at which coal and electrical energy can be purchased by the ordinary citizen corresponds to the losses incurred in the power station; that is to say that the cost of the generation and distribution of the electrical energy is covered by

[1] From the presidential address to Section G (Engineering) of the British Association, Toronto, August 7.

the better terms on which the power station can obtain fuel. In Glasgow the writer pays 5*l.* per ton for anthracite to burn in a slow-combustion stove; taking the calorific value of anthracite at 9000 kilowatt-hours per ton, which is equivalent to 14,000 British thermal units per lb., this works out at $7\frac{1}{2}$ kilowatt-hours for a penny. For electrical energy for heating and cooking purposes the writer pays a penny per kilowatt-hour. This ratio of 1 to $7\frac{1}{2}$ will correspond fairly closely to the overall efficiency of the power station. In view of the high efficiency and convenience of slow-combustion stoves, it is evident that electric heating cannot be expected to compete with them for continuous operation; for intermittent heating the question is very different.

Returning from this digression to the development of the direct-current dynamo, it may be noted that the drum armature now almost exclusively employed was invented in 1872 by von Hefner Alteneck, and gradually displaced the ring armature of Pacinotti and Gramme. Although Pacinotti's original ring armature was slotted, smooth armatures were preferred for many years, until the mechanical superiority of the slotted armature caused the disappearance of the smooth core with its wooden driving pegs which were employed to transmit the turning moment from the conductors to the core. The commutator and brushes were a great source of trouble, but by the gradual elimination of unsuitable material and by better design and methods of manufacture the commutator has been made a most trustworthy piece of apparatus. The difficulties of commutation, and especially the need of continual adjustment of the brush position, were largely overcome by the invention of the carbon brush by Prof. George Forbes in 1885. It should be pointed out that the commutating poles, which have come into use so much in recent years, were originally suggested in 1884, and are therefore older than the carbon brush.

The realisation of the idea of supplying electric current from a power station for lighting houses in the neighbourhood owed much to the energy and business ability of Mr. Edison. He exhibited his first "Jumbo" steam-driven dynamo in 1881, and installed two sets at Holborn Viaduct in the following year to supply current to neighbouring premises. The output of these sets was about 90 kilowatts at 110 volts, which was so much larger than anything previously constructed that the name "Jumbo" was applied to these sets. About 1890 the multipolar type began to replace the bipolar type for the larger sizes. The size of the single units employed in power stations gradually increased with the increasing demand, and by 1895, dynamos of 1500 kilowatts had been installed.

Ferranti was apparently the first to suggest that the power station should be outside the city, at a point convenient for fuel and water supply, and that the power should be transmitted into the city by high-voltage alternating currents. In 1890 he built the Deptford Station for the London Electric Supply Company, and installed 1000-kilowatt 10,000-volt alternators. This was the pioneer high-voltage underground cable transmission, and much was learnt concerning the peculiarities of alternating currents when transmitted over cables of considerable capacity. The following year, 1891, saw the first long-distance transmission by means of overhead conductors in connexion with the electrical exhibition at Frankfort-on-Main; three-phase power was transmitted, at 8500 volts, from a water-power station at Lauffen to Frankfort, a distance of 110 miles.

This development of the use of high-voltage alternating currents followed the development of the transformer. Gaulard and Gibbs patented a system of distribution involving transformers in 1882, and, although their patent was upset in 1888 on the ground of its impracticability, the present method of using transformers for the distribution of electrical power was introduced in 1885, and shown at the Inventions Exhibition in London in that year. Although from 1890 onwards there has been a steady increase in the size of alternators and transformers and in the voltage employed for long-distance transmission, the last few years have seen a really amazing increase in the size of the units employed. In 1913 the largest 2-pole turbo-alternators had an output of 3000 revs. per minute of about 7500 kilowatts; such machines are now made up to 30,000 kilowatts, and 4-pole alternators are running at 1500 revolutions per minute, with an output of 60,000 kilowatts. This increase in size and in peripheral speed has been made possible by improvements, both in the material and in the design. With a bursting speed 25 per cent. above the running speed, the peripheral speed can now be raised to 150 metres per second. Improved methods of cooling and a better understanding of the various causes of loss in the armature have enabled the materials to be used at higher current and flux densities.

This great increase in the size of units is not confined to the steam turbo-generator, as can be seen from the water-turbine sets recently added to the Niagara installation. Whereas the original Niagara turbines were of about 5000 horse-power, the new ones have an output of 70,000 horse-power at the low speed of 107 revolutions per minute.

The importance of cheap electric power has led to this great increase in the size of the units in the generating stations. Any slight difference of efficiency between a 10,000-kw. and a 60,000-kw. alternator is of little importance, and would certainly not counterbalance the decreased factor of safety due to concentrating the whole power supply in three or four large units, instead of distributing it between a dozen or more units. The reason for the adoption of the smaller number of large units lies almost entirely in the decreased capital cost per kilowatt of plant. In my opinion, however, there are many cases in which too much consideration has been given to this factor, and too little to the importance of a guaranteed continuity of supply.

Until recently, the only means of producing a large amount of high-voltage D.C. power was by connecting a large number of carefully insulated dynamos in series, as in the well-known Thury system of power transmission. Within the last two or three years another method has been developed, viz., the so-called transverter, which consists of an arrangement of transformers and a system of rotating brushes, whereby a three-phase A.C. supply is converted into an almost steady continuous current. The first apparatus of this type to be exhibited is installed at the British Empire Exhibition at Wembley, and is designed to deliver

continuous current at 100,000 volts. It can also be used for the reverse process. It would thus enable a three-phase generating station and a three-phase substation to be connected by a direct-current transmission line, thus avoiding not only the maximum voltage of 1·4 times the effective voltage, which was one of Lord Kelvin's objections to the A.C. system, but also all trouble due to the capacity and inductance of the line.

Electric traction represents one of the most important branches of electrical engineering. It shares with the petrol motor the distinction of having absolutely revolutionised the methods of transport within a single generation. In its origins it is nearly a century old, for attempts were made in the 'thirties to apply Faraday's newly discovered principle to the propulsion of vehicles, but, with very primitive motors and primary batteries, these attempts were doomed to failure. The development of the dynamo and motor in the 'seventies opened the way to further experiments, and at the Berlin Exhibition in 1879 a line one-third of a mile long was shown in operation, a locomotive drawing three cars. The first regular line was opened to traffic near Berlin in 1881; it worked at 100 volts and the current was collected from an insulated rail. Toronto was the scene of one of the earliest experiments in America; C. J. van Depoele, after some experiments at Chicago in 1882 and 1883, ran an electric locomotive in 1884 between the street-car system and the Exhibition in Toronto.

The difficulties were enormous. The carbon brush was not invented until 1885, and commutation in a reversible motor with copper brushes caused great trouble; armature construction and winding was in its infancy; the suspension of the motor and the method of gearing it to the car axles were problems which were solved only after much experience. Rapid progress was made after about 1887, and the closing years of the century saw an enormous development, the elimination of horse tram-cars throughout the world and the electrification of a number of city and suburban railways.

Of the various systems of collecting the current, only two have survived for street-cars, namely, the usual overhead wire and the exceptional underground conduit; in the case of railways there is no necessity for a conduit, and the conductor rail is carried on insulators above the ground-level.

Although 500-volt D.C. supply has been standardised for street tramways, the relative merits of D.C. and A.C. for electric railways has been a burning topic for more than twenty years, and is now perhaps more burning than ever. It is somewhat akin to the battle of the gauges in the early days of steam railways, for it involves in many cases the problem of through-running, if not now, in the not very distant future. Although the three-phase system was successfully installed in Northern Italy, it has grave disadvantages, and the battle now is confined between direct current at an increased voltage of, say, 1500 to 2000 volts, and single-phase alternating current. In the latter case there is, moreover, a further question as to the best frequency to adopt, this being usually either 25 or $16\frac{2}{3}$. The development of the A.C. commutator motor to the stage where it was applicable to traction took place during the first few years of this century, and, although in itself it is inferior to the D.C. motor, it introduces so many simplifications and economies in the transmission of the power from the generating station to the train that experts are very divided as to the relative merits of the two systems for main-line electrification.

I can only refer briefly to the applications of electrical power to chemical and metallurgical processes. Some of these are purely electro-chemical, others are purely thermal, while in many processes the electric current performs the double function of melting and electrolysing. The possibility of electroplating was discovered so early as 1805, but the commercial application of electro-chemistry on a large scale was impossible before the development of the dynamo. Within the last thirty years the provision of an abundant supply of electrical power has led to the creation of enormous electro-chemical industries; I need only instance the production of aluminium, carborundum, and calcium carbide. These industries have usually been established near a hydro-electric plant and provide a load of very high load-factor.

I turn now to what may be called both the earliest and the latest application of electricity; that is, its use for transmitting intelligence. One of the greatest factors in the development of our modern life has undoubtedly been the network of wires and cables which has spread over the whole earth, making possible an almost instantaneous transmission of intelligence and interchange of opinions. In the early days of electrical science the discovery of a new property of electricity was followed by attempts to utilise it for this purpose. So early as 1746 there are records of the use of frictional electricity for the purpose, and distances up to four miles were tried. In 1774 Lesage of Geneva proposed 26 wires in earthenware pipes with pairs of pith-balls at the end of each wire, which flew apart when the conductor of a frictional machine was brought near the other end of the wire. A current of electricity was unknown until Galvani's discovery in 1789, and Volta's pile was first constructed in 1792. Carlisle in 1800 found that water was decomposed by passing the current from a Volta pile through it, and this was the basis of the telegraph proposed by Sömmering in 1809, in which 26 wires ended in 26 metallic points arranged in a row along the bottom of a kind of aquarium. By means of a lettered keyboard at the sending end the current could be applied to any wire, and a stream of bubbles caused to rise from the appropriate point, each point being duly labelled with its appropriate letter. The magnetic effect of the electric current was discovered in 1819, and immediately replaced the previous methods in efforts to develop an electric telegraph; except for the attempts to make a high-speed chemical telegraph, all subsequent telegraph systems have employed the magnetic effect of the current. A great many of the fundamental inventions of telegraphy were made in the 'thirties; the list includes the needle instrument of Cooke and Wheatstone, the sounder of Henry, the dot-and-dash inker of Morse, and the use of the earth as a return by Steinheil. Although the needle instrument is now obsolete, the sounder and Morse inker are still commonly employed. Many have been the devices for increasing the amount of traffic which can be worked over a single line, either by the simultaneous use of the line by a number of

operators, as in the quadruplex and multiplex systems, or by punching the messages on paper tapes, which can then be fed into an automatic transmitter working at a speed ten to twenty times that attainable by a manual operator. In the most up-to-date systems the perforation of the tape is done by the operators working an ordinary typewriter keyboard, and the received message is printed in ordinary type, a single wire carrying eight messages simultaneously, four in either direction, at a speed of 40 words per minute.

The need for telegraphic communication between countries separated by water was so much the greater because of the slowness of other means of communication, but the difficulties in laying and maintaining 2000 miles of insulated wire on the bottom of the sea must have appeared almost insuperable to the early workers; fortunately, however, there were men who had the necessary vision and courage. The flimsiness of the early cables suggests that the pioneers underestimated the magnitude of the problem which faced them, which was perhaps fortunate. A cable was laid between Dover and Calais in 1850; it lived only a single day, but it was replaced in the following year by a successful cable.

The first cable was laid across the Atlantic in 1858, and, although in the light of our present knowledge we know that it could not have had a very long life, its failure after a few weeks of preliminary communication was primarily due to misuse owing to the ignorance of those in charge. Although much costly experience had been gained in the laying of cables in various parts of the world since this first attempt to span the Atlantic, the success of the second Atlantic cable in 1866 was largely due to the scientific ability of Kelvin and to his untiring application to the project at every stage of the manufacture and laying of the cable.

Turning to another branch of electrical communication, it is no exaggeration to say that modern business life has been revolutionised by the telephone, which will shortly celebrate its jubilee, for it was in 1876 that Graham Bell invented the magnetic telephone receiver, although others, notably Reis, had been working at the problem since 1861. Bell showed his telephone in operation at the Philadelphia Centennial Exhibition in 1876, and Kelvin, who was one of the judges, brought one back with him and demonstrated it to Section A of the British Association, at its meeting in Glasgow in the autumn of 1876.

A successful telephone system requires much more than efficient transmitters and receivers, and the great development which has taken place has been largely a matter of improvement in the design of the many elements that go to make up a telephone exchange. The modern manual central-battery exchange, in which one has only to lift his receiver to call the operator and be connected in a few seconds to any one of 10,000 other subscribers, is a marvel of ingenuity and construction. But this is now gradually being replaced by the greater marvel of the automatic system, in which the operator is eliminated and the subscriber automatically makes his own connexion to the desired subscriber. Attention should be directed to two outstanding inventions in the actual transmission of telephony over long distances, namely, loading and repeaters. It was Oliver Heaviside who in 1885 proposed to improve the range by increasing the inductance of the line. Although this revolutionary suggestion fell on deaf ears for fifteen years, it ultimately proved to be one of the great inventions of telephony; it is of special importance in underground and submarine telephone cables, the electrostatic capacity of which otherwise seriously limits the range. The other outstanding novelty is the introduction of repeaters at intermediate points in long telephone lines. These repeaters are specialised types of low-frequency amplifiers; they were made commercially possible by the invention and perfection of the three-electrode thermionic valve. The attenuated speech currents arriving at the end of a section of line are amplified and thus given a new lease of life before being passed on to the new section. By using a large number of such repeating stations, telephonic communication has been established between New York and San Francisco.

Turning now to radio telegraphy and telephony, one cannot but marvel at the rapidity of its development and the inroad that it has made during the last two or three years on the domestic life of the whole civilised world. The theory of Clerk Maxwell in 1864 and the laboratory experiments of Hertz in 1888 found their first practical application in Marconi's Italian experiments in 1895 and his demonstrations in England during the following year. Much of the rapid progress was due to his perseverance, vision, and courage in perfecting apparatus for short-distance work, and simultaneously experimenting over long distances, and thus, in the year 1901, settling by actual demonstration across the Atlantic the vexed question as to whether the waves would pass around the earth over distances of several thousand kilometres or go off into space.

The accomplishment of long-distance communication bristled with difficulties, largely due to unsuspected atmospheric effects which are still little understood; but such progress has been made and is continually being made that one dare not now adopt an incredulous attitude to the wildest dreams or forecasts of what is to be accomplished by "wireless." The commonplace facts of to-day would have appeared beyond the bounds of possibility ten or twenty years ago.

By the aid of electricity the energy of the coal or of the lake or river a hundred or even two hundred miles away is transmitted noiselessly and invisibly to the city, to supply light and warmth, to cook the food, to drive the machinery, to operate the street-cars and railways. By its aid one can flash intelligence to the most distant part of the globe, hold conversations with friends hundreds or even thousands of miles away, or sit in one's home and listen to music and lectures broadcast for the entertainment or instruction of all who care to equip themselves with what may almost be regarded as a new sense. Whereas thirty years ago a ship at sea was completely isolated from the life and thought of the world, it is now in continuous communication with the land and with every other ship within a wide range. In no branch of electrical engineering, however, is there any suggestion of having reached finality; on the contrary, rapid development is taking place in every direction, and we can look forward with confidence to an ever-increasing application of electricity to the utilisation and distribution of the natural sources of energy for the benefit of mankind.

The Frequency of Birds over the High Atlantic Ocean.

By P. JESPERSEN, Copenhagen.

THE Danish Commission for the Study of the Sea has, during the years 1913 and 1920–1922, under the direction of Dr. Johs. Schmidt, made a series of marine-biological investigations in the northern part of the Atlantic Ocean and in West Indian waters. The following four expeditions have been carried out: in 1913 with the schooner *Margrethe*, in 1920 and 1921 with the motor-schooner *Dana*, and in 1921–1922 with the research steamer *Dana*. So far as circumstances permitted, ornithological observations were also made on these expeditions, and it is on the diary of these observations, in combination with notes made on various voyages to the United States of America and to the West Indies, that the present account is based. In this I shall endeavour to give, on general lines, an idea of the frequency of birds over the various parts of the Atlantic.

In what follows I deal only with observations made on the ocean, and as such I consider those made at places where the distance from land was at least 50 miles. We have in all, observations on the high seas on 462 days, covering an area from the Faroes (about 62° N. lat.) to about 5° N. lat. In the area between 10° and 50° N. lat. the observations cover the whole breadth of the Atlantic from the coasts of Europe and Africa right across to the coast of America, whereas north of 50° N. lat. observations were available only for the eastern part of the Atlantic. Of the total number of days of observation the greater part, namely 254 days (about 55 per cent.), were spent in the area between 20° and 40° N. lat. and 40°-70° W. long., thus chiefly in the Sargasso Sea. Observations were made at all times of the year, the majority (about 62 per cent.), however, having been made in the six summer months, and there are few observations for the winter months north of 40° N. lat.

It is well known that the frequency of birds differs greatly in the various parts of the Atlantic. In general, it may be said that the frequency decreases greatly with the distance from land, but there are also other circumstances which may have an influence in this respect.

In order to be able to form an opinion as to how far the frequency of birds varies for the different parts of the Atlantic, I have, on the basis of the daily observations mentioned, calculated the average number of birds observed *per diem* in the various areas. Of course these figures can by no means claim to be in any way accurate, in particular for areas where the number of birds is large, but they appear to be sufficient for giving an idea whether the frequency of birds is great or small in the various parts of the Atlantic. On the accompanying chart (Fig. 1) the average number of birds observed *per diem* within an area of 10 degrees longitude and 10 degrees latitude has been given. The figures in parenthesis give the number of days on which observations were made within the respective areas. As mentioned above, only observations have been included which were made on the high sea (at a distance from land of at least 50 miles), and only such birds have been considered which may be assumed as generally living over the high sea. Characteristic coast birds and all inland birds have been excluded from these calculations.

I have employed the following method in making my calculations: so far as possible, the number of all birds seen in the course of a day was noted down. In areas where birds appear in large flocks, the number could, of course, only be estimated, and the figures given for such areas, therefore, make no claim to great accuracy. I have in such instances placed a > before

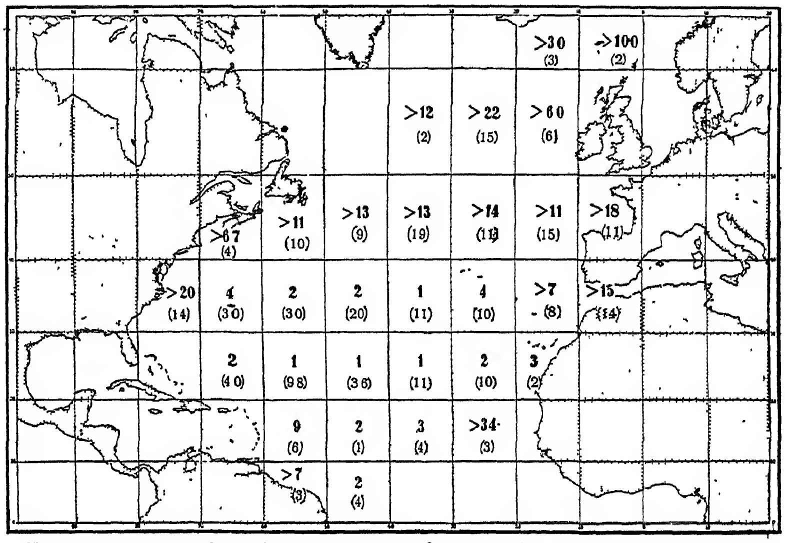


FIG. 1.—Average number of birds observed in 10° areas. The figures in brackets give the number of days on which observations were made in each area.

the number. When an average number is given for a certain area as, say, >13, this signifies that the average number of birds observed *per diem* within the respective area should be taken as, at the least, 13 birds. In many instances the actual number will probably be considerably higher. Birds which had followed the ship steadily for the whole day were counted once only, and the maximum number of birds seen together at one time during the day is, in such cases, given as the number of birds observed that day. Of course, there is always the possibility that the same individual bird is counted several times a day, and I have tried to avoid this so far as possible, but, particularly where individual birds of the same species are concerned, there will always remain the possibility of a repeated observation of one and the same individual. When a bird has been observed several times a day about the ship, I have considered it to be the same if at least six hours had not elapsed between the individual observations. Naturally fractions have resulted in these calculations, but all such fractions have been neglected. The average figure may therefore be understood thus: the number 1 means that the average

number of birds seen lies between 1 and 2, the number 2 that the average number lies between 2 and 3, and so on.

It is thus clearly seen in the accompanying chart that the frequency of birds is relatively larger the shorter the distance from land. Let us first consider the frequency of birds north of 40° N. lat. Here we have the largest number in the neighbourhood of the Faroes and to the west of Ireland. In the Bay of Biscay the frequency of birds is, however, considerably lower. The birds predominating in quantity here were fulmars, shearwaters, skuas, and kittiwakes.

Along the coast of America we have a high average figure south of Nova Scotia (>67). This is, in particular, caused by the large number of Wilson's petrels (*Oceanites oceanicus* Kuhl) which appears in the Gulf Stream area during the summer.

It will be observed that the frequency of birds decreases considerably with the distance from land north of 50° N. lat., but that we have quite considerable numbers over the middle of the ocean. The same applies to the area between 40° and 50° N. lat. Across the whole breadth of the Atlantic Ocean we, everywhere, meet birds in large numbers. It appears that the average figure is nowhere less than 11 birds a day. We are here chiefly in the Gulf Stream area, and the birds predominant are shearwaters, kittiwakes, skuas, and petrels.

South of 40° N. lat. we notice that the frequency of birds decreases greatly. We have, particularly, ample data on bird life between 20° and 40° N. lat., and it will be seen that the number of birds is particularly small within those parts of the northern Atlantic which is generally termed the Sargasso Sea. Regarding the area between 30° and 70° W. long., it will be observed that, with the exception of the Bermuda area, the number of birds, on the average, does not exceed 1-2 *per diem*. The most characteristic bird for the Sargasso Sea is the tropic-bird (*Phaëthon americanus* Grant), but besides this bird we also observed in smaller numbers various petrels, shearwaters, and kittiwakes.

Between 30° and 40° N. lat. we have, however, a high frequency along the east coast of the United States and about Madeira, and in the Bay of Cadiz. Between 20° and 30° N. lat. the average numbers are particularly low across the whole ocean. South of 20° N. lat. we find a surprisingly high average figure about the Cape Verde Islands, owing to the sooty-tern (*Sterna fuscata* L.) appearing in flocks. The number of days on which observations were made here is, however, so small that no particular importance can be given to the individual figures.

The great difference between the number of birds on the high sea north and south of 40° N. lat. is thus striking. For still further illustrating this difference we shall, in what follows, consider another circumstance. During the various voyages it happened repeatedly that, on some days, not a single bird was seen from the ship, and it is of interest to have a look at the geographical position of such days of observation on which no birds whatever were seen. In the following chart (Fig. 2), showing the routes taken by the *Margrethe* in 1913 and by the *Dana* in 1920 and 1921, the days of observation are marked. The black dots indicate the positions in which no birds were seen during the day.

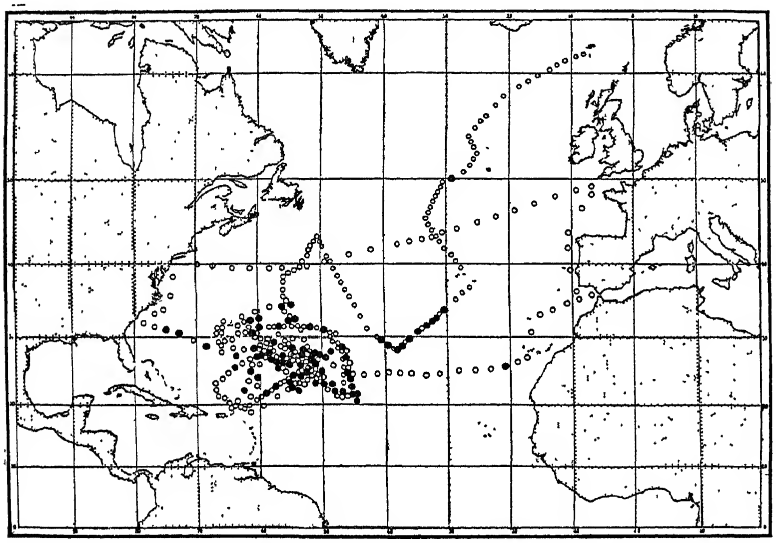


FIG. 2.—Routes of the *Margrethe*, 1913, and the *Dana*, 1920 and 1921. Black dots indicate positions in which no birds were observed during the day.

It thus clearly appears that almost all days of observation on which no birds were seen were south of 40° N. lat., being 1 day and 73 days respectively north and south of this latitude. The percentages are 1·3 and 28·1 respectively of all days of observation. This circumstance, furthermore, shows how small is the number of birds south of 40° N. lat. compared with the parts of the Atlantic north of this latitude.

The longest period during which the Danish expeditions did not see any birds was four days, and the longest periods during which no birds were seen were all within the range of the Sargasso Sea, where the distance from land is considerable.

According to the available observations, it appears that the number of birds within the range of the Gulf Stream is at least ten times as large as in the Sargasso Sea, and the question arises: what is the reason that birds are so scarce in the Sargasso Sea as compared with the area of the Gulf Stream? In large portions of the Sargasso Sea the distance from the nearest land is very great, and it is therefore possible that this fact is one of the reasons for the scarcity of birds, but this can scarcely be the real reason. In the central parts of the Atlantic, between 40° and 50° N. lat., where the distance from land is very considerable, the frequency of birds is, relatively, much larger than in any part of the Sargasso Sea.

The reason for the scarcity of birds in the Sargasso Sea is far more probably to be found in the small amount of food in this part of the ocean as compared to the Gulf Stream area. It seems reasonable to assume that the special fauna (fishes, crabs, etc.) belonging to the large quantity of drifting "Gulfweed" (Sargassum) must afford nourishment for more extensive bird life, but it is questionable whether this fauna plays any part as food for birds in the Sargasso Sea.

I have thus, in examining the contents of the stomachs of birds from the Sargasso Sea, never found the slightest trace of the characteristic fauna from the Sargassum, and it is therefore possible that it is difficult for the birds to catch the fishes and crabs hiding in these dense masses of drifting sea-weed. Examinations of the stomachs have, on the other hand, always shown that the birds, at least the majority of them, live on flying fishes and cephalopods. This shows that the birds in the Sargasso Sea do not avail themselves of the special Sargassum fauna but seek their food amongst fishes, cephalopods, etc., living free in the water.

It is therefore interesting to study the quantity of macroplankton to be found in the Sargasso Sea and the Gulf Stream respectively. In a previous paper[1] I have drawn a comparison between the quantity of macroplankton in various parts of the Atlantic, and it appears from this comparison that the quantity of macroplankton in the central parts of the Atlantic between 40° and 50° N. lat. is at least ten times as great as that in the Sargasso Sea.

The reason for the scarcity of bird life in the Sargasso Sea, as compared to that in the Gulf Stream area and, on the whole, in the northern Atlantic, may, therefore, safely be sought in the much smaller quantity of food to be found in the Sargasso Sea as compared to the parts of the Atlantic lying farther north.

[1] P Jespersen: On the Quantity of Macroplankton in the Mediterranean and the Atlantic Rep. on the Danish Oceanogr. Expeditions, 1908–10, vol. iii. 3. Copenhagen, 1923.

The Planet Mars.

By Dr. W. H. STEAVENSON.

THIS year's favourable opposition of Mars, which on August 22 is nearer to the earth than at any time between the eighteenth and twenty-first centuries, would seem a fitting occasion for a brief review of our present knowledge of the planet, together with an estimate of the prospects and probable direction of future research.

The object aimed at in physical observations of Mars may be considered as twofold. First, it is desired to determine, so far as available means will allow, the true appearance of the features presented to our view on the planet's surface; and, secondly, it is hoped, by careful and repeated observation of these features and the changes that occur in them, to reach some definite conclusions as to their real nature. Both of these objects have been kept in view from the earliest days of the telescope, but it is only in recent years that the second of them has begun to show reasonable prospect of fulfilment. The fact is, of course, that the one object is dependent on the other, so that the first must be attained, approximately at least, before the second can be pursued with any confidence of success. Thus it comes about that the history of Martian observation naturally divides itself into two stages, which we may term respectively that of cartography and that of interpretation. One, of course, is but a development of the other, and there is no sharp dividing line between the two.

From the earliest days of the telescope, it was recognised that the "spots on Mars" were relatively permanent features of the planet's surface, but the first attempts to construct even a rough map of them did not meet with much success. The drawings made by Sir William Herschel late in the eighteenth century are among the first on which we can recognise a number of markings that have since become familiar to us, and it was this great astronomer who, by his study of the polar caps, contributed the first piece of intelligent interpretation of Martian phenomena. But the first map of Mars, properly so called, was not produced until 1840, when Beer and Mädler gave to the world the results of their systematic work with a refractor of less than four inches aperture. This first map was followed, during the succeeding fifty years, by many others of increasing completeness and accuracy, each being in general the work of a single observer. During this period, thanks largely to the work of Schiaparelli, the areographical positions of the main features were fixed with some approach to finality, and a firm foundation was thus laid for future work. Finally, during the past thirty years or so, progress in cartography has been notably accelerated by the introduction of the co-operative system in observation, as exemplified by the work of such bodies as the British Astronomical Association. Meanwhile, as a result of these advances, we have begun to feel ourselves in a position to attack the problem of rational interpretation, based on the data so far accumulated. Much has, in fact, already been accomplished in this direction, and it is satisfactory to find that the theories are beginning to stand the crucial test of prediction.

To summarise all that is so far known with certainty is not altogether easy, for many of the results of observation, doubtless in most cases quite trustworthy, still lack that general confirmation which would justify us in accepting them with complete confidence. However, the following would probably be accepted on all hands as a fair statement of the present condition of definite knowledge concerning Mars.

(1) The fact of the general permanence of the larger dark markings has been established, and their positions and outlines have been determined with considerable accuracy. In other words, we are in a position to construct a very recognisable map of the planet, as regards its main features.

(2) As a result of the above, it has been possible to ascertain the inclination of the planet's axis within a few minutes of arc, and to determine the rotation period within less than a tenth of a second of time.

(3) The size and rate of diminution of the polar caps has been shown to bear a definite relation to (*a*) the progress of the Martian seasons, (*b*) the distance of the planet from the sun, and (*c*) the extent of solar radiation as indicated by the sun-spot cycle. There is now general agreement that the caps must represent frozen water, the alternative of carbon dioxide, suggested some years ago, being for many reasons untenable.

(4) The large dark markings, while in general permanent in position and outline, are known to

undergo changes in intensity, both general and local. Some of these changes of intensity are clearly seasonal and regular, while for others no definite period can yet be assigned. They are probably of a secular or irregular nature. Some typical examples are shown in Figs. 2-4. Changes of colour, of seasonal origin, undoubtedly occur, but the regularity of these has not been satisfactorily demonstrated, and all the markings do not appear to share the same changes.

(5) Both dark and light regions of the planet are subject to temporary obscuration by patches of (*a*) white and (*b*) yellow material. The former, which occur most frequently near limb or terminator, have been variously ascribed to cloud, fog, snowfalls, or hoar-frost; the latter to cloud, dust-storms, or blown sand. We are, however, not yet justified in definitely attributing a particular obscuration to any one of these causes, though probably all are in operation at some time or other.

(6) Apart from the larger markings, the existence has been established of an intricate system of finer details, the exact form of which is still uncertain, though there is not the least doubt as to its objectivity.

(7) Finally, satisfactory photographic confirmation has been secured of practically all the above results.

Further elaboration here of all the sections of this summary is not necessary, but special reference should be made to the sixth, since under this is included the so-called "canals," which have loomed so large in the more recent history of Martian observation. There seems to be a widespread impression, among those not in direct contact with the subject, that the existence of fine linear markings on Mars has been definitely and finally disproved. Actually, the question still remains entirely open in the opinion of those best qualified to judge. In the case of objects which lie so near the limits of visibility, factors of a climatic, instrumental, and personal nature are bound to enter very largely into the matter, and there is consequently room for much difference of opinion. The "canals" having been seen and drawn as fine lines by experienced observers using apertures of 36 and 40 inches under good climatic conditions, the failure to see them with a somewhat smaller aperture in a less favourable position does not carry an overwhelming amount of weight; and in any event such evidence is purely negative. On the other hand, it does not seem that the linear character of the markings in question has yet been completely demonstrated. No doubt the decision must ultimately come from the large apertures, but it is an unfortunate fact that the ideal combination of a large and perfect instrument, a first-rate climate, and a thoroughly efficient and trustworthy observer, who is also a finished draftsman and entirely free from the bias of preconceived ideas, has never yet been attained. The evidence of photography cannot be regarded as conclusive in either direction, though it has at least proved the objectivity of detail that is approximately linear. Since, however, it is impossible as yet to obtain a distinct photographic image of any features that are beyond the visual reach of an eight-inch telescope, it follows that a really narrow line, if recorded at all, can only appear as a diffuse marking on the plate, so that we are still left in doubt as to its true structure.

It is, perhaps, unfortunate that so much time and effort has been expended on this difficult question of the finer detail, especially with instruments that are in any event inadequate for a final decision. Observers

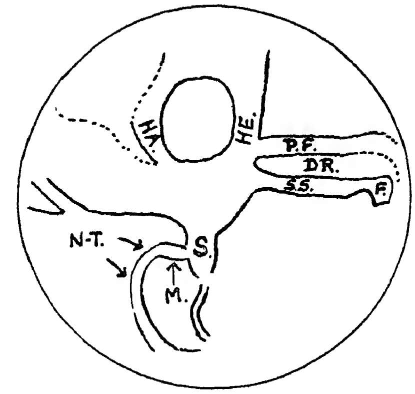


FIG. 1.—Key to Figs. 2-4.
HA = Mare Hadriacum. S S. = Sinus Sabæus.
HE = Hellespontus. S. = Syrtis Major.
P F. = Pandoræ Fretum. M. = Lacus Moeris.
D.R = Deucalionis Regio. N-T. = Nepenthes-Thoth.
F. = Sinus Furcosus.

FIG. 2.—Mars. September 1909.
Note great development of Lacus Moeris, considerable breadth and intensity of Pandoræ Fretum, and darkness of M. Hadriacum as compared with Hellespontus. North end of Syrtis Major pointed.

FIG. 3.—Mars. July 1922.
Lacus Moeris only moderately developed as a mere continuation of Nepenthes-Thoth Pandoræ Fretum narrow and faint, being far less prominent than Sinus Sabæus. Sinus Furcosus darker than the latter. Hellespontus very dark. North end of Syrtis Major blunt.

FIG 4.—Mars. July 1924.
Lacus Moeris poorly developed. Pandoræ Fretum scarcely visible as a separate marking. Deucalionis Regio very pale as compared with area to the south of it. Hellespontus darker than M. Hadriacum. North end of Syrtis Major more pointed than in 1922.

are apparently beginning to realise this, and more attention is now being paid, and that more profitably, to the less doubtful subject of changes in the large markings. This work is well within the compass of the instruments generally to be found in the hands of amateurs, who would do well, in the present writer's opinion, to leave the finer details to the larger apertures. In thus getting back to the partially neglected study of the more conspicuous features, we shall be correcting the mistake of attempting to run before we can walk. A good beginning has been made, but it is well to realise that it is no more than a beginning, and it will probably be many years before sufficient data have been accumulated to enable us to judge of the soundness or otherwise of current theories.

In recent years there has been much speculation as to the possible climate and temperature of Mars, and the density and composition of its atmosphere. This sort of thing is apt to blind us to the cold fact that our actual knowledge of these things, if knowledge it can be called, is still exceedingly vague, uncertain, and even contradictory. In view of this, the free and confident use of such definite terms as "cloud," "fog," "hoar-frost," and "vegetation" would seem to be somewhat premature, and liable to check progress by giving rise to a false impression of finality in our deductions. However eager we may be for a quick explanation of observed appearances, we cannot better serve the interests of research than by keeping an open mind.

Obituary.

PROF. JAMES SETH.

IN Prof. James Seth, who died of failure of the heart on July 24, at the age of sixty-four years, Edinburgh has lost one who belonged to the great race of Scottish professors. Educated at George Watson's College and the University of Edinburgh, he went through a complete course of training for the ministry at the Free Church College. Turning from his original intention to his true vocation, he studied philosophy at Leipzig, Jena, and Berlin. In 1883 he became assistant to Prof. Campbell Fraser in his own University, and two years afterwards was appointed professor of philosophy at Dalhousie College, Halifax, Nova Scotia. In 1892 he accepted a chair in Brown University, Providence, Rhode Island, and four years later the Sage professorship of moral philosophy in Cornell University. From Cornell he was recalled in 1898 to succeed Prof. Calderwood in the chair of moral philosophy in Edinburgh.

During his twenty-six years' tenure of this post, Seth made a place for himself in the life of the University and the city that would bear comparison with the most distinguished in the long line of his predecessors. Not so well known as his elder brother and colleague, Andrew Seth Pringle-Pattison, he had the same high standard of scholarship in philosophy and much of the same distinction of style in his written work. The writer of the "appreciation" in the *Scotsman* on the day after his death, remarked on "the unique partnership so fruitful in good results" between the brothers. For the rest, his methods as a teacher and the place he took in the life of the University and the city were entirely his own. Endowed with great readiness of speech and a singular power of entering into the minds of his students, he was able in spite of the size of his classes to perfect a form of catechetical instruction which was the delight of his students and made "Prof. Jim" for a quarter of a century one of the most popular teachers in Scotland.

On the other hand, related by his subject of moral (which, on his interpretation of it, meant also political) philosophy to the civic life of the community, Seth took the warmest practical interest in all advanced movements. He held that "it is for the State to emancipate from the slavery of social conditions the toiling masses of society, to endow those who are citizens only in name with a real ethical citizenship—the franchise of a complete and worthy human life," in a word, "to co-ordinate the industrial with the ethical life." It was in such a "regulative socialism" that he found the *via media* between individualistic and communistic extremes. In the same spirit he interested himself in the Settlement and kindred movements and took a leading part in the establishment of a course of study in social science with the view of linking these more closely with the University. His wide connexion with America and the Continent and his generous hospitality made the bachelor home, which he shared with his younger brother John, a rendezvous of scholars from all parts of the world as well as of his more intimate friends in Britain. It was altogether in harmony with the genius for friendship that was so marked a feature of his character that he died in the course of a round of calls upon acquaintances who were themselves in trouble. *Sic vivamus ut sic moriamur.*

Seth's chief contributions to philosophy were his book upon "Ethical Principles" (1894), now in its fifteenth edition, and the volume in the series Channels of English Literature on "English Philosophers and Schools of Philosophy" (1912). In the former of these he expounds in a masterly way and with a fine sense of the power of the English language the sober form of idealism with which, by his own teaching not less than that of Campbell Fraser, Simon Laurie, and his brother, philosophy in Edinburgh has been identified. It differs, as the student of philosophy knows, from that associated with the great sister University in the West under the influence of Edward Caird and Henry Jones, chiefly in the emphasis it lays on separate will and personality as an ultimate category and its more definite teaching on the subjects of theism and individual immortality. This is not the place for comparison and criticism, but we touch here on what is probably the main issue between Idealistic philosophers at the present time and we can ill spare the help which so open-minded and "synoptic" a thinker as Prof. Seth might have rendered in clearing it up in the greater leisure of the retirement to which he had been looking forward. We may hope that he has left behind him some record of his maturest thought upon it that may yet be published.

J. H. MUIRHEAD.

Dr. R. H. Jude.

Much regret was felt in scientific circles at the death of Dr. R. H. Jude on June 1. Until his retirement during the War, Dr. Jude was for more than thirty years in charge of the Mathematical and Physical Department of Rutherford College, Newcastle-on-Tyne, and he played a very prominent part in the higher education particularly of young engineers on Tyneside, many of whom now occupy prominent positions in the engineering world. For several years he had been a victim of diabetes, but, in spite of ill-health and progressive deafness and blindness, he retained to the end a brave fortitude in his outlook, an active and a clear mentality, and his letters rarely lacked in that spark of dry humour so characteristic of him in earlier years.

Dr. Jude was born on December 31, 1853, at Camberwell, and after receiving his early education at King's College School, Strand, he gained a scholarship and proceeded to Christ's College, Cambridge, where he took the B.A. degree. In 1876 he was bracketed 18th Wrangler in the Mathematical Tripos, and the following year he obtained a first class, with a special mark of distinction, in the Natural Science Tripos. One year later, in 1878, he gained the degree of D.Sc. of the University of London, and for a short period after graduation he also studied at the University of Heidelberg.

During his long association with Rutherford College, Dr. Jude played a large part in the development of the scientific side of that institution. In the words of one of his former colleagues, he had " a profound and ready grasp of his subjects, and a singularly lucid power of exposition " ; but above all he wielded " a quickening influence over his students, based on a lively sense of sympathy with both their difficulties and their aspirations, and he so mingled these qualities with a forestalling courtesy as to combine in a rare degree all that gives efficiency and charm to a lecturer." Whilst he took a keen and helpful interest in and had unbounded patience with his elementary students, Dr. Jude was untiring in his efforts to develop the advanced work of his department. In addition to advanced courses in mathematics, he also instituted courses in higher mathematics for engineers and a tutorial class for advanced students, held on Saturday afternoons. Those of us who were privileged to attend these classes saw him at his best, and found in him a friend to whom no labour was a trouble, so long as it might benefit his students. Not merely content with solving his students' difficulties, he often pursued their problems and derived interesting and original results, and although Dr. Jude did not publish many original papers in mathematical and physical subjects, this was undoubtedly due to the monopolisation of his time by teaching duties and problems arising from them. Nevertheless, we owe a great debt to him for his admirable treatise on physics, and for his books on elementary and advanced electricity and magnetism, all of which have been favourably reviewed in these columns. By their clearness and originality of treatment these books have done inestimable service to British students of science. Much of the apparatus described in them was of his own design.

In his youth, Dr. Jude acquired proficiency in French and German, and could converse freely in either language. Moreover, in addition to Greek and Latin, he made a study of Arabic. Quite late in his active career, and in connexion with the translation of one of his books into Russian, he took up the study of that language so that he might be able to look over the proofs of the translation. But perhaps the most remarkable of his linguistic achievements took place after his retirement. Living in Wales, and constantly hearing it spoken, he obtained a considerable knowledge of Welsh, in spite of failing vision, and was able to converse freely with the villagers.

By his kindly, unobtrusive, and gentlemanly bearing, Dr. Jude was endeared of all with whom he associated. His active life was spent in the service of others. He had much to give, and gave of it unstintingly. Our sympathy goes out to his widow, for whose unfailing encouragement and help he was ever grateful, especially in later years of failing sight and hearing.

Robert W. Lawson.

Prof. Albert Hesse.

The issue of the *Chemisches Zentralblatt* for May 28 announces the death at Berlin—Wilmersdorf—of Prof. Albert Hesse, who was editor of that journal from 1902 until 1923. He died on May 10, after a long and painful illness, at the comparatively early age of fifty-seven. The systematic co-ordination and abstracting of pure and applied chemical literature was the main achievement by which Dr. Hesse is known, and his great success in this field has been and is still of great service to the chemist. The fusion of the *Chemisches Zentralblatt* with the abstract journal of the *Zeitschrift für angewandte Chemie* in 1919 was a great achievement for Dr. Hesse, and this union will help also in the solution of the problem, yet unaccomplished, of including an abstract of the current patent chemical literature of the world.

Before concentrating on editorial work Dr. Hesse was an active chemist both from the academic and industrial aspects. He was a pupil of Wallach, and made a close study of the ethereal oils. His studies on sesquiterpene alcohols and the odoriferous constituents of flowers, including jasmin, rose, ylang, tuber, and orange-blossom, and the synthesis of camphor were among the problems which at different times occupied his attention. He was associated for some time with the famous firm of Heine and Co. of Leipzig, and his name occurs in many patents connected with essential oil.

In addition to his editorial work and his contribution to patent literature, reference may be made to two publications of a more economic character. Jointly with Prof. Grossmann he wrote a report entitled " England's Trade War and the German Chemical Industry," and in 1909 in the Wallach-festival publication he dealt with " The Development of the Ethereal Oil Industry in the last 25 years in Germany."

J. Reilly.

Current Topics and Events.

Anything that will cheapen the cost of the electrification of our railways deserves serious study at the present time. In the United States, a continually increasing number of automatic sub-stations are being employed in electric traction. It is interesting, therefore, to notice that in the extension of the London Electric Railway from Hendon to Edgware, which opened for traffic on August 18, there is a completely equipped automatic sub-station. Although there are several of these stations in Great Britain in connexion with lighting networks, this is the first to be used for traction purposes. The building has been designed for three 1200-kilowatt rotary converters with all the necessary control gear and accessories. The sub-station gets a 10,500-volt three-phase supply from the Lots Road Generating Station at Chelsea, the frequency being $33\frac{1}{3}$. It is situated at Burnt Oak, which is one mile from the Edgware terminus and four miles from the manually operated sub-station at Golder's Green. To start a rotary converter at Burnt Oak, it is only necessary to close a switch at Golder's Green, all the subsequent operations being automatic. Cooling air for the transformers is supplied by a centrifugal blower. The automatic devices protect the machines in all conditions of overload. For example, when the load is too heavy, the circuit breaker opens and a resistance is inserted in the machine circuit and the rotary is disconnected from the supply mains. After a short interval the circuit breaker closes again and connexion is re-made. If the fault has been cleared, normal operation is resumed, but if not, the same sequence of operations happens again If this happens a fixed number of times, the breaker is automatically locked and an engineer must be sent to investigate and remove the fault.

At the conversaziones of the Royal Societies of Western Australia and New South Wales, held on June 28 and July 2, fitting celebrations were made of the centenary of the birth of Lord Kelvin. At the former there was an extensive exhibition of Kelvin apparatus and relics, including a series of photographs and engravings of the Old College at Glasgow. Lecturettes were given illustrating various phases of Kelvin's life and work. Their titles were "Gyroscopes," "The Atlantic Cable," "The Age of the Earth," "Glacier Motion," and "Solar Heat." At Sydney, Prof. H. S. Carslaw—an old pupil of Kelvin's—gave a memorial oration. He recalled the fact that two of the most famous periods in the history of mathematics in England were the age of Newton and the years during which the school of mathematical physics arose and flourished in Cambridge. Of the great names of that period without doubt the greatest was Kelvin. He had made valuable contributions to almost every branch of mathematical physics, and was the greatest pioneer of the age of electricity. It was peculiarly fitting that Australians should commemorate Kelvin, for his work on navigation made it much safer for them to cross the 12,000 miles of ocean which separated them from the homeland. The age of steam has done much for Australia, but the age of electricity has already done more.

Scotland has never yielded, nor is it likely to yield, the range of prehistoric civilisations which successively flourished in southern Britain, for the incidence of the Ice Ace markedly reduced the habitable period in the northern kingdom. Yet it is possible that Scotland may furnish evidence on an important and obscure stage in the more recent history of prehistoric man, namely, on the transition from Azilian to neolithic culture. So far, the shell-mounds and kitchen middens of Oransay and elsewhere have given clues to one culture or the other, but none has shown a continuous habitation throughout the critical period. It is our belief that the places most likely to reveal such are the caves, and since these have been very imperfectly surveyed in Scotland, each new cave-excavation not only deserves commendation and encouragement, but raises hopes of outstanding discoveries. On the Mull of Kintyre, about four miles south of Campbeltown, the Kintyre Antiquarian Society has, with the assistance of Mr. L. M'L. Mann, set about excavating St. Kieran's Cave. Their findings, recorded in the *Glasgow Herald* of July 31, included an incised symbol clearly of Christian origin, flint implements, bone objects, and a human skeleton, buried in a short cist, and accompanied only by a worked flint. The skull is compared conjecturally with the famous dolichocephalic skulls of the Oban caves. The digging revealed the presence of several layers of habitation, but the details given are not sufficient to indicate the ages of the deposits, and the results of expert examination of the relics will be awaited with interest.

Mr. J. H. Maiden, who for nearly twenty years has been government botanist of New South Wales and director of the Sydney Botanic Gardens, has recently retired under the age-limit Born at St. John's Wood, London, in 1859, Mr. Maiden went to Sydney about forty-five years ago. Before leaving England he had studied botany under Prof. R. Bentley and Prof. D. Oliver, and shortly after settling in Sydney was employed in the Technological Museum there, becoming curator and secretary in 1882, after a year's service as acting curator. While holding these offices his botanical work was chiefly connected with economic plants, on which he contributed numerous papers to journals. In 1889 he published his well-known book: "The Useful Native Plants of Australia," and in 1890 appeared the first of the three editions of his "Wattles and Wattle-barks." During Mr. Maiden's directorship of the beautiful Botanic Gardens, Sydney, to which he was appointed in 1896, many improvements in them have been effected, and he had the satisfaction of seeing the erection of the fine new building in which are accommodated the Botanical Museum and Herbarium: this was completed in 1901. Holding important administrative and advisory posts it might be supposed that he would have had little time for authorship. Yet by his writings he has won a world-wide

reputation and a high position among the greatest botanists of his adopted country. "A Critical Revision of the Genus Eucalyptus," now in its seventh volume, is in itself a fine achievement. "The Forest Flora of New South Wales," of which seven volumes have been completed, is another. Mr. Maiden is also the author of several other independent works and of a multitude of papers in journals of societies and other publications. He has served a number of the scientific societies of Australia in various offices, and was president of the Royal Society of New South Wales in 1896–97 and again in 1911–12. Mr. Maiden became a fellow of the Linnean Society of London in 1888, and in 1915 received its Gold Medal. He was elected a fellow of the Royal Society in 1916, and in the same year was appointed to the Imperial Service Order. We look forward to the completion of his valuable Revision of the Genus Eucalyptus during the coming years.

IN a circular letter dated July 10, M. Sampaio Ferraz, director of the Meteorological Service of Brazil, urges the publication of reports of abnormal weather or abnormal wind circulation in some central publication, say the *Meteorological Magazine*. The abnormal wind and excessive rain experienced in Brazil during April and May of this year are quoted as a type of the information which might be collected in this manner. M. Ferraz suggests that all information for a particular month should appear in the same number of the *Meteorological Magazine*. The scheme put forward appears to us to be highly desirable, and it is to be hoped that either the *Meteorological Magazine*, or the Royal Meteorological Society, through its Quarterly Journal, will be able to make arrangements to publish such reports as are suggested from all the meteorological services and institutes of the world, two or three months in arrear. In the past, the publication of reports of abnormal weather conditions has been left largely to the *Meteorologische Zeitschrift*, but it is highly desirable to make a more systematic collection of such data, and to make them available in an English periodical.

THE August issue of the *Scientific Monthly* contains the address of Dr. Arthur D. Little to the Engineering Division of the National Research Council of the United States, under the title "Research: the Mother of Industry." After a short account of the great advances in industry during his own lifetime, he directs particular attention to the developments of the decade 1890–1900, during which Hall brought out the aluminium process, Acheson made carborundum, Willson calcium carbide, Diesel invented his engine, Cross and Bevan made artificial silk, Little himself produced cellulose acetate, Röntgen discovered the X-rays, Becquerel radioactivity, Madame Curie radium, and Marconi sent a wireless message across the Bristol Channel. On nearly every one of these discoveries an industry has been founded, and Dr. Little points out that while in the past the United States has prospered because of its cheap land and abundant raw materials, it can only maintain its position in the future by making use of every assistance science can afford, and that industry must in its own interest support research generously.

THE value of chemical evidence in archæology is generally known, and there are many examples of mistakes which have arisen from lack of chemical knowledge; for example, the description of early metal objects from Mesopotamia as "bronze," whereas in reality they are almost pure copper. In a very brief note in the *Cairo Scientific Journal* for July, Mr. A. Lucas gives some further examples. The black appearance of mummies is generally attributed to the use of bitumen, whereas it is either the result of a change of the flesh itself or of resin, or gum-resin, which has blackened by natural processes. No evidence has yet been found of the use of bitumen or mineral pitch, although they may have been used in Ptolemaic times. Castor oil has been described as honey and as natron, alkali used in glass-making has been described as potash though it was generally if not always soda, and the presence or absence of cobalt as a blue colour for glass and as a pigment has been asserted and denied without any chemical evidence. Most of the archæologists who have made really valuable progress have paid attention to the assistance which can be given by chemistry, and in future it may be assumed that the services of the chemist will be called in even more extensively than in the past.

IN the *Empire Review* for August, the problem of the mentally defective is raised again. It is a problem which is always with us, but which for that very reason is likely to be overlooked. Discussions on the subject usually resolve themselves into heated opposition to all the suggested schemes for dealing with the defective, or into a fatalistic resignation to the futility of all schemes. Miss Nelly Burdett pleads for the reanimation of public interest in the subject, which shall lead to more earnest efforts to put these people into such a position that they can be useful members of their own society, since by their defect they are debarred from adapting adequately to general society. She points out the disquieting fact that with our present system of half-hearted treatment, the ranks of the mentally defective are being increased. In 1906 it was estimated that one person in every 250 was mentally defective. Now it is one in every 200. A Royal Commission appointed in 1904, after four years' work, made recommendations which have not yet been realised. A point of considerable interest, not dealt with in this article, is that emotional conflict may mask itself in some form of mental defect, and much later trouble could be spared by suitable treatment and understanding from the beginning.

AT the conference on Illuminating Engineering held at the British Empire Exhibition on August 12, a paper was read by Mr. L. Gaster summarising developments at the International Conference on Industrial Hygiene, and the meeting of the International Illumination Commission recently held in Geneva. The former afforded a good opportunity of interesting experts on hygiene in illumination, and the importance of good industrial lighting in the interests of the

health and safety of workers was freely recognised. It was suggested that the International Illumination Commission should bring before the International Labour Bureau of the League of Nations problems in industrial lighting, etc., with a view to their being studied by the Governments of the respective countries. Industrial lighting also formed the subject of much discussion by members of the International Illumination Commission. A feature of interest is the large number of scientific and industrial bodies which co-operate with the American Illuminating Engineering Society in the revision of their codes of school and factory lighting. Arrangements have been made for the National Research Council to supervise researches on the results of better lighting. These facts were mentioned to illustrate the desire for co-operation in the United States and the recognition by manufacturers and gas and electricity supply undertakings that researches, in order to carry weight with the public, must bear the impress of scientific and impartial authority. After describing the methods adopted in America for promoting public appreciation of the benefits of good lighting, Mr. Gaster urged the need for a comprehensive scheme in Great Britain, in which all interested in illumination could join. A resolution approving the proposal of the Illuminating Engineering Society to initiate such a scheme was passed unanimously. A paper on "Illumination of Highways from the Motorists' Point of View" was read by Mr. E. H. Fryer, and there was also an interesting discussion on the methods of lighting adopted at the British Empire Exhibition.

A FULL report of the International Meteorological Conference of Directors and of the meeting of the International Meteorological Committee at Utrecht, September 1923, an account of which appeared in NATURE of October 6, 1923, p. 523, has recently been issued as Publication No. 112 of the Koninklijk Nederlandsch Meteorologisch Institut. The volume consists of 191 pages. At the meeting in London, September 1921, it was arranged that the next meeting should be held at Utrecht. The president was Sir Napier Shaw, and the assembly represented 20 countries, including, in addition to Europe, Argentine, Brazil, India, Japan, and New Zealand. There was a very copious agenda, the rapid progress of meteorology of late years rendering international understandings and arrangements essential to its further advancement. Land and marine meteorology over the whole globe were considered as well as upper air observations, and the general collection and distribution of obtained results. The Appendices give a large amount of information, considered internationally, and afford much material for quiet study. The discussion includes terrestrial magnetism and electricity of the atmosphere, solar and terrestrial radiation. Special consideration is given to the exploration of the upper air, the arrangement of dates for international ascents of pilot-balloons and ballons sondes, and a time-table of issues by radio-telegraphy in connexion with weather telegraphy and weather forecasting. The subjects include marine meteorology with its important considerations of world-wide interest, réseau mondial, agricultural meteorology, the propagation of sound by means of explosions, and the study of clouds. These international meetings lead to essential uniformity in methods of observation and discussion and aid much in the extension of observations for land and sea areas. For weather forecasting and for considerations of physical meteorology on land or sea as well as in the air above the surface of the globe, trustworthy and comparable data are available—the aims and objects being arranged by personal contact among those interested and responsible for the world's meteorology.

THE *Chemiker Zeitung* announces that Prof. W. J. de Haas, of Groningen, has been appointed to succeed Prof. H. Kamerlingh Onnes, of Leyden, who has resigned.

AT the annual autumn meeting of the Institute of Metals to be held in London on September 8-11, Mr. W. M. Corse, of the National Research Council, Washington, D.C., will lecture on "Recent Developments in Non-Ferrous Metallurgy in the United States, with Special Reference to Nickel and Aluminium-Bronze." Visitors' tickets for the meeting can be obtained from the Secretary of the Institute, Mr. G. Shaw Scott, 36-38 Victoria Street, Westminster.

AT the monthly General Meeting of the Zoological Society of London held on August 13 it was reported that the number of visitors to the Society's gardens during the month of July had been 266,559, showing an increase of 85,538 as compared with the corresponding month last year. The total number of visitors to the Gardens since January 1 had been 1,079,608, an increase of 249,239. The number of visitors to the Society's aquarium since its opening on April 4 had been 316,347.

A SURVEY of the Great Barrier Reef area has been undertaken by the Commonwealth Government of Australia, and the naval sloop *Geranium* has been detailed for the work. The vessel will have a seaplane attached for general help and work in the survey, and a preliminary flight around the coastline of Australia was recently completed with the view of deciding the kind of assistance which can best be afforded from observations in the air. The commander of the *Geranium* is a member of the Barrier Reef Committee of the University of Queensland, and he will take with him two scientific investigators attached to the Committee.

A PRIZE for the physiology and pathology of altitude has been founded by the Alpine Sanatorium of Semmering, Austria. One thousand gold krone are offered to the author of the best work accomplished or published in the last two years, which has extended our knowledge of the action of alpine climate on man. The prize is intended in the first instance for Austrians, but foreigners can also be considered if their work has been carried out in Austria. Printed or typed papers should reach the Kanzlei of the Akademie der Wissenschaften, Wien I., Universitätsplatz 2, before December 31, 1924. Some notable English reports both from the Andes and the Himalaya deserve to be laid before the commission of judges, even if they may have to be marked not for competition.

THE communications of the Society of German Men of Science and Physicians—Gesellschaft Deutscher Naturforscher und Ärzte—are now distributed monthly with *Die Naturwissenschaften*. The *Mitteilungen* give general information about the Society. Subscriptions have been reduced to a minimum of three marks; those who can are asked to give more. The 88th meeting is to be held at Innsbruck, Austria (Sept. 21-27). The president-elect, Dr. Richard Paltauf, professor of pathology in Vienna, died on April 21. Some of the chief addresses at Innsbruck will be by Dr. Hoche on the body-mind problem, Dr. Hess on the physiology of work, Dr. Frisch on the senses and language of bees, Dr. Sommerfeld on atomic researches, Dr. Penck on the aspect of the Alps. Those intending to take part in the Innsbruck meeting should communicate with Prof. D. A. Defant, Büro der Naturforscher Versammlung, Physik. Institut, Schöpfstr. 41, Innsbruck.

THE Castner-Kellner Alkali Co., Ltd., has issued recently a number of informative pamphlets dealing with some of the chemical products which it manufactures. Among these is sodium perborate, which is used for bleaching textiles, oils, fats, waxes, and foodstuffs. In the solid state this substance is quite stable, but on solution in water it yields hydrogen peroxide, caustic soda, and borax, the last named acting as a water-softener. The formation of caustic soda might be harmful, but can be readily obviated by adding sodium phosphate or bicarbonate, or a pure mineral acid. The pamphlet entitled "Chlorine and Chlorine Products in relation to Public Health" describes the manifold applications of liquid chlorine, bleaching powder, and sodium hypochlorite. Liquid chlorine is being used increasingly for sterilising potable water, and it is not generally known that a large proportion of the London water supply is now treated with this substance in the ratio of 0·5 part of gaseous chlorine to one million of water, whereby the water is improved bacteriologically about one thousand times. It is well known that diseases may be contracted from the water in public swimming-baths; 1-3 parts of chloride of lime per million of water, applied every 1-2 days, will effectually sterilise the water. Other applications are for sterilising canal or river water before use in condensers at power-stations, and for disinfecting streets, sewage, the farm and the kennel. A third pamphlet contains, *inter alia*, directions for using bleaching powder, calcium hypochlorite and sodium hypochlorite solutions to bleach textiles (other than wool), artificial silk, and paper pulp, with or without previous scouring with alkali and a solvent such as trichloroethylene. Bleaching agents containing chlorine are now in use for bleaching and desulphurising mineral oil, and for converting unsaturated hydrocarbons in such oil into saturated hydrocarbons.

Our Astronomical Column.

THE PERSEIDS OF 1924.—Mr. W. F. Denning writes: "From observations made at various stations, it appears that the shower has been less abundant than usual. On the important night of August 11, the weather was unfavourable and only enabled a few meteors to be seen through breaks in the clouds. At Ashby, Lincolnshire, Mr. King, watching occasionally a partially overcast sky between $10^h\ 29^m$ and $13^h\ 58^m$ G.M.T., saw 28 meteors, of which 19 were Perseids, from a radiant well defined at $46° + 57°$. At $13^h\ 20\frac{1}{2}^m$ a splendid Perseid several times brighter than Venus was observed shooting from $30° + 52\frac{1}{2}°$ to $26° + 50\frac{1}{2}°$. A brilliant Perseid was also seen from Warwick Road, London, S.W., and from Greenwich, S.E., on August 12 at $9^h\ 42^m$ G.M.T. It was about three times as bright as Venus and left a luminous trail for about ten seconds. The direction of the flight was from α Ursæ Majoris towards α Comæ Berenicis, so that the object was evidently a very fine Perseid. Further observations of the two large meteors referred to above would be valuable."

AN ANTI-RELATIVITY THEORY.—Articles in the July and August numbers of *Scientia* by Prof. La Rosa contain a daring suggestion as to the cause of variability in stars, including the outburst of Novæ. Few are likely to accept the author's suggestion as a *vera causa*, but the articles are worth reading as a study of the consequences that would follow from his assumptions as to the laws governing the speed of light.

Prof. La Rosa rejects not only the Einstein postulate as to the constancy of the measured speed of light, but also the previous postulate that the speed is conditioned by the medium conveying the light-waves. In fact, he reverts to the corpuscular theory, supposing that the speed of the corpuscles is the resultant between the speed of the luminous body and that of the emission of corpuscles. Taking, for example, a star moving with a speed of 60 miles per second in a circular orbit the plane of which passes through the sun, the difference between the speeds of emission at the two elongations is 1/1500 of that of light, and if the time between the elongations were (say) 2 months, and the star 250 light-years from the sun, the light emitted at the two elongations would reach us simultaneously. There would thus be a rhythmic increase and diminution in the amount of light received during the revolution. Novæ are explained by supposing very eccentric orbits of cometary form so arranged as to give a great concentration of light in the neighbourhood of perihelion.

PROPER MOTIONS OF THE HYADES.—Memoir No. 35 of the Kapteyn Laboratory at Groningen, by the Director, Prof. van Rhijn, deals with the proper motions of the Hyades stars, based on photographs taken at Helsingfors. It contains a full discussion of the measures and reductions and a catalogue of 395 proper motions. The final mean annual proper motion of the cluster is given as 0·102″ in Position Angle 102°. It is not difficult to separate the cluster stars from the non-cluster ones by their motion; this appears clearly when the motions are plotted as a series of dots the abscissæ and ordinates of which indicate the motion in x, y respectively.

The density of non-cluster stars is found to be somewhat less than in other regions of the same galactic latitude, and it is noted that the same peculiarity has been found in other cluster regions. We may conjecture that the cluster stars are surrounded by dust-bearing regions, which absorb some of the light of stars in the background. The presence of such dust round the Pleiades stars is shown by their accompanying nebulæ, the spectra of which appear to indicate that they are dust-clouds reflecting the star light.

Research Items.

POISONS AND WITCHCRAFT IN PAPUA.—In the August issue of *Man* the Rev. R. Lister Turner describes the methods in the use of poison in witchcraft in Papua, which exhibit a close resemblance to those practices recorded by Dr. Codrington as being followed in the island of Florida by the Melanesians. This Papuan custom, which is known by the name of "Vada," consists in stunning the victim with a club and then forcing poison plants down his throat. A magical formula is repeated over the victim and he is gradually brought back to consciousness. Later he dies. It is said that an alternative method is to place the poison in a cut in the thigh, which is healed magically so as to leave no trace of the wound. Three poisons are believed to be employed—"Matua" and "Tua," which are plants, and "Gavroa," a worm with yellow stripes; but owing to the secrecy which is essential to the success of the "Vada," it is not possible to say more than that there is a probability that poisons are used. A method in which poisons are not used has come under the notice of the authorities. In this the abdomen of the victim is pummelled with cobble stones after he has been rendered unconscious. The result in one case was death from a broken spleen.

THE INHABITANTS OF NEW CALEDONIA AND NEANDERTHAL MAN.—Prof. Fritz Sarasin has made a detailed comparative study of the osteology of the New Caledonians and Neanderthal man, of which the results are published in *L'Anthropologie*, xxxiv., Nos. 3-4. He finds that in a large number of their skeletal characters the New Caledonians show a closer affinity to Neanderthal man than do Europeans; but, on the other hand, in certain features they are even more primitive than the Neanderthal group. Among these are irregularities in the region of the pterion, a more pronounced prognathism and the more simian conformation of the nasal skeleton. There are, however, a number of divergences in the two groups. The New Caledonians, for example, have a more vaulted cranium, rectangular orbits, and the radius shows little or no curvature, while all the bones of the skeleton are less robust. The general conclusion is that the New Caledonians form one of a closely-related group, including Australians, Tasmanians, and other Melanesians, which is more primitive than the fossil representatives of *homo sapiens*, Piltdown man being set aside as still indeterminate. It resembles closely the primitive ancestor of existing races, Rhodesian man possibly being the proto-Australian type, and the connecting link between the Austro-Melanesian group and a pre-Neanderthaloid ancestor.

PRECURSORS OF THE JAPANESE EARTHQUAKE.—In two earlier papers the late Prof. Omori described semi-destructive earthquakes at Tokyo in 1921 and 1922, and, in a posthumous paper (*Seismological Notes*, No. 4, 1924) he refers to the strong earthquake of January 14, 1923. The focus lay some distance to the north of that afterwards in action on September 1, being about 30 miles N.N.E. of Tokyo. From the duration of the preliminary tremor he assigns to the focus the unusually great depth of about 30 miles. In an appendix dealing with future earthquakes in Tokyo (written before the great earthquake) he ventures on some predictions which, unfortunately, have not been verified. "Tokyo," he says, "may be assumed to be free in future from the visitation of a violent earthquake like that of 1855, as the latter shock originated right under the city itself, and as destructive earthquakes do not repeat from one and the same origin, at least not in the course of 1000 or 1500 years," and "a great suboceanic earthquake off the coast of Izu or Awa-Kazusa peninsula . . . is not likely to occur for at least some 60 or 70 years to come." Yet it was in the latter district that the recent earthquake had its origin.

THE ACTION OF PITUITARY EXTRACTS.—In a recent paper in the *Quarterly Journal of Physiology*, L. T. Hogben and W. Schlapp (vol. xiv. p. 229) have studied the effects of pituitary extracts on vertebrates other than mammals, with the view of finding whether there is any evidence of the existence of independent components showing vascular activity in the extracts. Adrenaline produces a rise of blood pressure in all four classes of air-breathing vertebrates, but pituitary extracts in physiologically significant doses have no such effects on the blood pressure of the reptile or amphibian, there being in fact a fall of pressure in birds and reptiles, though corresponding doses of the same preparations produced pressor effects in mammals.

INSULIN FROM THE COD-FISH.—Dr. H. W. Dudley, in the current number of the *Biochemical Journal* (xviii. p. 665), shows that insulin may be obtained in large amount from the islet tissue of the cod-fish. The yield, even under unfavourable conditions, was as high as 13·12 rabbit units per gram, and probably more would have been obtained from absolutely fresh islets. It is estimated that the islet tissue of the cod contains, weight for weight, about ten times as much insulin as is present in mammalian pancreas. The material was collected from the Yorkshire shore fisheries in February and March, and placed in picric acid solution, which fixed the tissue and converted the insulin into a picrate. The insulin-containing picrate fraction was extracted with watery acetone, and the picrate converted into the hydrochloride by the method previously described by the author. The finding of such large yields of insulin in the islet tissue, which is structurally identical with the islets of Langerhans of the pancreas in mammals, furnishes us with very good proof that it is really in the islets of the pancreas that insulin is normally produced.

SOUTH AMERICAN NON-MARINE MOLLUSCA.—Dr. H. A. Pilsbry (Proc. Acad. Nat. Sci. Philad., vol. lxxvi.) has, under a common title, united four notes on South American non-marine Mollusca. The first deals with shells from Lake Titicaca, whence very few mollusca are known and nearly all of species confined to the lake. The varieties of *Planorbis andecolus* are specially described and figured photographically on an excellent plate. There are, further, four species of Littoridina, two being new, and a new species of Pisidium (*P. titicacensis*) which, if correctly figured, exhibits hinge characters differing from those usual to the genus. The second note, on South American genera of Ancylidæ, discusses four out of the five genera known from that continent, including a new genus, Anisancylus, founded with *Ancylus obliquus*, Brod. and Sowb., as type. Descriptions of two Brazilian Amnicolidæ, being new species of Idiopyrgus and Potamolithus, form the third note. A note on Pupillidæ collected by Dr. Baker in Curaçao and its dependencies in 1922 concludes the series. A new species and new sub-species are described. Text figures accompany all four notes.

WEATHER AT HONGKONG.—A report of the Royal Observatory, Hongkong, for the year 1923, prepared by the director, Mr. T. F. Claxton, has recently been

issued. In addition to the annual report, a Monthly Meteorological Bulletin is issued. Automatic records are obtained for most elements, and considerable care is exercised to secure the greatest accuracy. The monthly and annual values of the several elements are given in the December Bulletin, and in lesser detail in the Annual Report. The mean temperature for the year was 72°·5 F., which is 0°·6 above the normal for the past 40 years; the absolutely highest temperature was 92°·9 on August 4 (the highest on record for the 40 years is 97°); the lowest temperature was 45°·7 on January 4, whilst for the 40 years the lowest reading is 32°. Temperature was considerably above normal in March, November and December, and moderately above in April and May; in the remaining months it was nearly normal. The total rainfall for the year was 106·74 in., which is approximately 22 inches more than the normal for 40 years, the greatest fall in one day was 11·50 in. on October 31, when in a single hour the fall was 2·82 in. The maximum wind velocity for one hour was 106 miles on August 18, which is only 2 miles less than the highest on record; the maximum squall velocity on the same day was at the rate of 130 m.p.h., the highest on record. Tracks of typhoons and depressions in the Far East during the year 1923 are given, and the centre of the memorable storm of August 18 is shown to have passed over Hongkong, travelling westward from off the sea. The seismograms show that 141 earthquakes were recorded in 1923. In connexion with upper air research, 49 flights with pilot balloons were made during the year. Daily weather reports from surrounding stations are given in each Monthly Meteorological Bulletin.

A THEORY OF SUPER-CONDUCTIVITY.—Herr E. Kretschmann, in the *Annalen der Physik* for June, develops a new mathematical theory of electrical conduction, and uses it to explain the phenomena near the absolute zero of temperature. He rejects the idea that the conduction electrons are moving in any kind of quantum orbit, and deals with them as a swarm, moving under the influence of an infinitely small e.m.f.; he concludes that the specific conductivity of a homogeneous isotropic metallic conductor is infinite, for a swarm with given velocity in the direction of the current, when and only when the mean retardation in this direction vanishes. This will be the case, according to the quantum theory, if none of the conduction electrons spring into the closed quantum orbits of the molecules of the substance. He supposes that near the absolute zero all the quantum orbits are occupied, so that the conduction electrons cannot spring into them. When the temperature rises above a certain critical point the exterior orbits "are broken up" by the thermal vibrations of the molecules; this apparently means that electrons in these orbits are thrown off in haphazard directions, and conduction electrons fall into the orbits after an interval, so that the average velocity of the swarm is diminished.

THE CRYSTALLINE STRUCTURE OF SOLIDIFIED ARGON.—Herr F. Simon and Fräulein C. von Simson describe, in the *Zeitschrift für Physik*, July 2, an X-ray investigation of solid argon, in which they employed the method previously used by them for hydrogen chloride. Liquid hydrogen was passed through the capillary tube of the apparatus to cool the surrounding argon to its freezing point. The lattice is cubic, face centred, with closest spherical packing; at $T=40°$ abs. $a=5·42\pm0·02$ Å, and the density is $1·62\pm0·02$. The density of the liquid at the melting point, 84° abs., has been found by Baly and Donnan to be 1·42. The atomic radius (Bragg's formula) is 1·92 Å, while the mean ionic radius of K^+ and Cl^-, which have the same electron arrangement as argon, is 1·52 Å. It appears then that the atomic radius depends on the forces acting between the atoms, and is smaller the larger the forces of attraction. The authors make use of their results to study argon from the point of view of the theories of Mie, Grüneisen, and Born. Only approximate results can be obtained, as the data are incomplete; but it appears that the behaviour of argon is different from that of the metals, in which the exponent of the term representing attractive force at close range is $m=3$, while for argon it may be about 9.

THE INTERVALS BETWEEN THE OPTICAL DOUBLETS AND TRIPLETS.—Prof. A. Landé contributes a paper to the *Zeitschrift fur Physik*, June 24, in which he deals with the relationship between the optical doublets and the X-ray relativity doublets. It cannot be expected that the former should show the same exactness in satisfying Sommerfeld's simple approximate formula as that author has found in the case of the X-ray spectra. In the latter case the processes take place in the inner electronic spheres, where the conditions alter in the simplest (linear) manner with increase of the nuclear charge, $+Ze$. The optical terms, on the other hand, depend on the motion of a photo electron, which for the greater part of its path is outside the atomic kernel; but which enters the kernel, and approaches very close to the nucleus; this last part of the orbit is of the greatest importance in determining the distance between the components of the doublet, which depends on the screening s at this position. Sommerfeld found for the L doublets, from Nb (41) to U (92), $s=3·5$; for the optical doublets of elements with large atomic numbers s varies about the number 4, for all p terms; only with the first elements of the first period is s equal to 2. The difference between the value 4 and Sommerfeld's value 3·5 for the L doublets may be due to the fact that in the latter an L electron has been removed, which diminishes the screening. The paper directs attention to the difficulties involved in the explanation of the doublet distances by the relativity theory, both for X-rays and for light; and also to those involved in the alternative magnetic explanation.

SEDIMENTARY ANALYSIS OF PHOTOGRAPHIC EMULSIONS.—Mr. F. F. Renwick has devised a new method of attacking some of the problems connected with photographic emulsions that promises to give results of great interest (Journal of the Royal Photographic Society, August). He has constructed a water bath with regulators so that its temperature falls very slowly but with great regularity, 0·4° C. an hour. The melted emulsion is thus brought to its setting point without appreciable interference from convection currents. The block of emulsion obtained is about 15 cm. high, and slices are cut parallel with its base from various parts of it for examination. It is found that passing from the top layer downwards the particles of silver salt increase in size, the percentage of silver salt increases, the proportion of silver iodide to the total silver haloid increases, the turbidity decreases, and the sensitiveness increases. The sensitiveness in one case of the emulsion being 65, the layers gave as results 16 at the top increasing to 110 at the bottom. By putting a clear gelatin layer under the emulsion, the larger particles fall into it and are thus more completely separated than by the other method, or the sedimentation may be repeated on any given layer if a more complete separation is wanted. Seven photomicrographs are given to demonstrate the results.

Imperial Botanical Conference.

THIS conference, the first of its kind, was held at the Imperial College of Science and Technology, South Kensington, on July 7-16, under the presidency of Sir David Prain. It was attended by a large number of overseas and home botanists, and many interesting topics were discussed.

Plant Physiology.

In the Section of Plant Physiology, Dr F. F. Blackman organised an extremely illuminating discussion on "The Physiology of Crop Yield." In the general introduction to this discussion he indicated the five chapters of modern scientific investigation which combine to illuminate the problem of crop yield. The first dealt with the experimental study of the factors and conditions affecting growth, and was illustrated by papers from Dr. F. G. Gregory on the study of plant growth with controlled artificial light, and from Prof. V. H. Blackman on the results of electro-culture experiments. The second chapter concerned the ontogeny of the crop and duration of the development sequence. It was pointed out that crop-yield covers a wide range of special cases, the desired crop being either the whole plant, its wood, fibre, or bark, or some special morphological part, such as the petals, stamens, fruit, or seed hairs. The desired part comes at the end of a long development sequence, and, for this aspect of crop yield, detailed studies are required of the normal sequence of development of each crop plant combined with an exploration of its plasticity under natural and artificial variations of environment. Other problems arise out of the varying duration of the development sequence in the individual crop plants. These were illustrated by Dr. W. L. Balls' account of his method for analysing the development of the cotton plant by collating records of the significant stages prior to the production of cotton. The next chapter dealt with the quantitative relations between the final yield and the various "factors" which affect the development of the crop plant. Several investigators, notably Mitscherlich, have tried to formulate a general law governing the relation between the plant yield and the magnitude or intensity of all outside factors, but Mr. G. E. Briggs showed the inadequacy of such formulæ.

The fourth phase of this symposium treated of the complexity of the plant's spatial environment, namely, the soil, and was illustrated by Mr. E. J. Maskell's account of critical pot-culture work at Rothamsted. Lastly, the influence of the weather on crop yield was considered, and the great difficulty of disentangling the effects of the various components of the weather was pointed out. Dr. R. A. Fisher showed that by the methods of statistical analysis significant relations between weather factors and yield can be computed where a sufficient mass of data is available. In the general discussion which followed the presentation of the main thesis, Mr. F. L. Engledow drew a comparison between a tillering plant, such as wheat, with a non-tillering plant, such as cotton, as regards development sequence and its effect upon crop yield. Dr. H. M. Leake directed attention to the enormous influence of rainfall upon plant growth in monsoon countries, owing to the elimination of temperature as a limiting factor.

Genetics.

In the Section of Genetics, Mr. F. L. Engledow opened a noteworthy discussion on "The Economic Possibilities of Plant Breeding," Mr. W. Bateson being in the chair. Mr. Engledow confined his attention chiefly to the possibilities of hybridisation in the English wheat crop. He pointed out that the economic possibilities of breeding are measured by the prospects of producing new forms which will give better financial returns than the old. Enhanced returns may accrue from higher yield, better quality, and a number of other amenities, many of which indirectly affect yield and quality, and all influence financial return. Quality improvements, such as those exhibited by the varieties Yeoman and Yeoman II., produced by Professor Biffen, have great promise. Improvement of yield is more difficult, as the average yield of wheat per acre is already higher in England than in any other country. The best policy is to try to identify the plant characters which mainly govern yielding capacity, and then by synthetic breeding to produce optimum combinations of these characters suitable for different localities. Among "other amenities" are the qualities of disease-resistance, non-lodging, early ripening, and winter hardiness, all of which are of great importance, and the attainment of which seems reasonably possible. Dr. R. N. Salaman dealt with similar problems in potatoes, Mr. M. A. Bailey dealt with cotton, and Mr. J. M. F. Drummond with oats and turnips. In the other session devoted to genetics, Prof. J. Percival opened a discussion on "The Value of Selection Work in the Improvement of Crop Plants," to which contributions were made by Prof. R. G. Stapledon, Dr. W. L. Balls, Mr. G. O. Searle, and Mr. G. N. Sands.

Plant Pathology and Mycology.

Much attention was paid at the Conference to problems in plant pathology and mycology. Dr. A. W. Borthwick opened a discussion of much interest on the "Relation of Forest Pathology to Silviculture," in which an appeal was made for closer co-operation between the practical cultivator and the pathologist, and for the latter to confirm his laboratory investigations by further research in the forest. Mr. W. E. Hiley stressed the importance of the non-parasitic agencies which frequently cause severe mortality in seedling trees and loss of increment during later stages of growth. He urged the need of a careful study of the particular edaphic and climatic requirements of the various species used for forestry purposes, indicating that in the absence of complete suitability the trees often die or grow slowly, and are more than usually susceptible to parasitic attack. Dr. J. W. Munro and Dr. Malcolm Wilson also contributed to this discussion. Another session in this Section was devoted to a discussion on "The Relation of Plant Pathology to Genetics." This was introduced by Mr. F. T. Brooks, who summarised recent achievements in breeding disease-resistant varieties of crop plants, and pointed out the limitations of this method of disease-control. He stressed the importance of co-operative effort between plant pathologists and geneticists. Prof. Groom dealt with "Fungal Attacks on Timber," indicating the enormous losses which occur, and urging the need for more intensive research upon the problems involved. There were also interesting discussions on "Bud-rot of Palms," "Mosaic Disease of Sugar-cane," and "Brown Bast Disease of Rubber Trees."

Systematic Botany and Geology.

In the Section of Systematic Botany and Ecology, Dr. A. W. Hill opened a discussion on "The Best Means of Promoting a Complete Botanical Survey of the Empire." The present position of the Botanical Survey of the Empire was reviewed, and attention

was directed to the most pressing needs of the moment. It was pointed out that in some regions, such as India, Malaya, and South Africa, great progress had been made in the systematic study of their floras, but that in others, such as East Africa and some of the West Indian islands, little had yet been done to explore the vegetation resources. In urging that further facilities should be afforded to British botanists to go out and explore the floras of our overseas dependencies, Dr. Hill stated that at present we were indebted chiefly to foreign botanists for a knowledge of the plants of some parts of the Empire. A strong appeal was made for temporary interchanges of posts between overseas and home botanists. The value of a detailed botanical survey was emphasised, especially from the point of view of the economic resources and possibilities of the Dominions, Colonies, and Protectorates.

Another important and closely allied subject dealt with at the conference was the consideration of the best means of promoting the study of natural vegetation of the Empire in its ecological aspect. This was introduced by Mr. A. G. Tansley. It was pointed out that the modern study of vegetation regards each kind of plant covering, be it forest, scrub, or grassland, as having a natural life, economy, and history of its own. If a given type of vegetation is sufficiently well adapted to the local climate and soil, not threatened by the invasion of plants better adapted to all the conditions, and undisturbed by man, it will maintain itself indefinitely. Many kinds of vegetation are, however, mere transition phases to other types, which gradually replace the former covering by the natural invasion of individuals of different species, as, for example, when new soil, such as the alluvium of a river, blown sand, or the like, is occupied first perhaps by grasses, then by shrubs, and finally by trees. Again when forest is felled or burned, or when grassland is burned or overgrazed, new plants, often resulting in a different type of vegetation, invade and settle in the area. The original vegetation may or may not ultimately return. All these phenomena of the development of vegetation are referred to as "succession."

Such facts have, of course, long been well known to practical foresters and stock-raisers, but their systematic investigation is a modern study, vigorously pushed forward, especially in the United States, and also in some of our own colonies and Dominions, especially in New Zealand and South Africa, and to some extent in India and Burma. The results have proved most valuable as a practical guide to the treatment of the land. Overgrazing, for example, may greatly lessen or even destroy the value of a cattle range, by crippling the vegetative powers of the dominant pasture plants, and thus letting in less valuable or worthless herbs, "throwing back the succession" to an earlier stage. The range then has to be allowed time to recover by the natural succession of the grasses and other pasture plants which originally occupied it. A carefully regulated system of grazing or burning will maintain the most useful phase of the succession. The first step towards the discovery of the most scientific and therefore the most economical and productive treatment is the careful and thorough study, by trained investigators, of the natural composition, behaviour, and succession of the vegetation. This has been amply proved, to mention but two examples out of many, by the work of Sampson in the United States and of A. H. Cockayne in New Zealand. The laws of behaviour of forests, on which alone can be based the most scientific treatment, are subject to quite similar laws, and a marked feature of this part of the Conference was the hearty support given by men with long practical experience of forestry work, such as Prof Troup, of Oxford, who was for many years a member of the Indian Forest Service, and by Mr. R. S. Hole, for some years botanist at the Forest Research Institute at Dehra Dun, to the proposals of the conference.

After very brief summaries of the present state of knowledge of the vegetation of the Crown Colonies and Protectorates, and of the Dominions, and a series of papers from representative men of experience of such work in different parts of the Empire, there was a general discussion, concluding with resolutions. These aimed at the creation of a small central body to superintend the preparation of a series of outline monographs on the vegetation of the different parts of the Empire. Though our knowledge is still, of course, very incomplete, it is of great importance to collect and present what we do know in accessible form, which will serve as a starting-point for further work It is further proposed to arrange for the systematic record of future work uniform with the monographs. It is also proposed that the central body, when formed, should at once put in hand the preparation of a pamphlet or small handbook, co-operatively produced by the best available authorities in the Empire, dealing with the aims and best methods of field work in the study of different kinds of vegetation, so that a practical guide may be available for new workers in this field throughout the Empire. The conference also adopted a resolution that an adequate training for work on vegetation should involve a practical training in systematic botany and ecology by competent teachers in the field.

At the closing session of the conference Prof. F. O. Bower gave a striking address on the training of botanists, the possibility of effecting interchanges of staffs, and the need for further facilities for research, which was followed by an animated discussion.

The conference terminated with a hearty vote of thanks to Sir David Prain for presiding over its labours.

F. T. BROOKS.

The Maximum Recorded Temperature of the Air and its Circumstances.

IN the midst of the semi-desert plain of Jefara, between the coast of Tripolitania and the interior plateau, there exists an official Italian settlement situated about 25 miles south of Tripoli and 25 north of Gharian at some 300 feet above sea-level, known as Azizia. In 1913 Prof. Filippo Eredia, as a member of an agricultural commission, visited the locality, and wisely saw to the establishment of a meteorological station on the lines followed at many other points in the colony. He took great pains to ensure the accurate functioning of the instruments after approved methods, and has recently published the results for a period of seven, not, however, consecutive years: 1913, 1914, 1915, 1919, 1920, 1921, 1922. (Ministero delle Colonie. Sul Clima di Azizia (Tripolitania), Rome 1923.)

The mean yearly temperature for this period is 70·8° F. (21·6° C.), not an excessively high figure, but appropriate to the latitude well outside the northern tropic, the range being between 87·4° F. (30·8° C.) in July and 52·8° F. (11·6° C.) in January. Therefore, though the summer is torrid, there is a very decided cool season, slight frost being occasionally experienced with an absolute minimum for the period in question of 31·1° F. (−0·5° C.) in December. Maximum temperatures as high as 110° F. (43·3° C.), the figure

for each of the five months May to September, the absolute maximum occurring with cloudless sky and S.W. wind, on September 13, 1922, namely 136·4° F. (58·0° C.), during a period of extremely high temperature throughout Tripolitania, even the coastal city of Tripoli recording as high as 113° F. (45·0° C.). This appears, and is so represented by Eredia, to be the highest authentic temperature of the air ever recorded on the globe, exceeding by 2·3° F. (1·3° C.) the previous "record" of 134·1° F. (56·7° C.) in Death Valley, in the south-eastern desert of California, on July 10, 1913, occurring, that is, in a similar, or rather higher latitude, close to the summer solstice, when the sun is nearly vertical. Records exceeding 115° F. (46° C.) are stated to be common in Tripolitania, whilst other extremes from other regions, quoted for comparison, are 127·4 F. (53·0° C.) in the Wargla oasis of Algeria, on July 17, 1879, and 125·9 F. (52·2° C.) at Jakobabad in N.W. India, on June 13, 1897.

The remarkable circumstance connected with the Azizia "record" is, we think, not so much the extra-tropical location, since it is towards the dry sub-tropical belts, where the days are longer, that the most intense summer heats occur, but that the season of its occurrence there should have been equinoctial. The mean temperature of the month of September for the seven years in question is exceedingly high, surpassing not only that of May, which is usual in northern extra-tropical latitudes, but also that of June, which is quite abnormal. This anomaly appears to be a local accentuation of the common Mediterranean characteristic of excessive summer heat lingering to a later date than in higher latitudes, where the much greater difference in the length of the day between solstice and equinox usually permits a rapid decline in temperature when August is over. Yet we know that even in England there comes every few years, with a drift northward of warm Mediterranean air, a surprising development, or resumption, of severe heat in September, with afternoon maxima at about 90° F. (32° C.), which sometimes causes the climatological student to wonder how the oblique equinoctial sunshine in this latitude has enough strength to raise the temperature to such levels. It should be remembered, however, that apart from the large reserve of heat stored in the air and the land- and sea-surface in autumn, and its easy transport by air currents from heated southern regions, enabling a smaller amount of solar radiation to raise the temperature to 80° or 90° F. (27° to 32° C) than is necessary early in the summer, the very fact that the equinoctial sunshine is feebler, implying a smaller amount of surface heating, involves in turn, in conjunction with the relatively warm upper air in the autumn, a shallower vertical temperature gradient, and lessened tendency to convection, than at the high solstice. The result of this is that the heat is kept more to the surface, and that September "heat-waves," when they do occur, are liable to be scarcely less severe than those of July and August, and rather more so than those of May and June, when the fierce insolation, coupled with the yet cold upper air in early summer, favours instability with removal of the warm air from the surface and a checking of the afternoon maxima.

The circumstances attending the highest temperature which has yet been "caught" by our observing stations, may be summarised as follows: It occurred during a period of cloudless sky with light winds from the heated regions of the Sahara, in the middle of a semi-desert plain well inland from the sea, in a latitude (32½° N.) which, astronomically at least, belongs to the temperate zone, at a date (Sept. 13) only ten days on the summer side of the autumn equinox, when the sun is nearly half-way between its extreme solstitial position. The time of year is a prominent illustration of the general climatological principle that the seasonal extremes of temperature, even in continental regions, tend to lag well behind the corresponding extremes in the intensity and duration of sunlight. The latitude, too, illustrates the somewhat paradoxical principle that in general it is not the equatorial or hottest climates, that is, those with the highest mean temperatures, that furnish the occasional extremes of heat, say above 120° F. (*circ.* 50° C.), but the cooler and drier climates, near the confines of the tropics, which are intensely hot during the summer months.

L. C. W. BONACINA.

Past and Passing Peoples of Polynesia.

SOME important studies of two Polynesian peoples are published by the Bayard Dominick Expedition in the Memoirs of the Bishop Museum at Honolulu.[1] In vol. ix. Mr. H. D. Skinner gives a comprehensive account of the almost extinct Moriors of Chatham Islands. Of these only two living representatives were found in a population of foreigners, most of whom were Maoris. One other was living in New Zealand. In vol. viii. Mr. R. Linton discusses the material culture of the Marquesans, and in vol. ix. Mr. L. D. Sullivan their somatology. These are also a dying and diseased race and Mr. Sullivan doubts whether there is a wholly sound physical specimen alive, while Mr. Linton considers that their language and portions of their culture may be preserved for several generations by their numerous half-Chinese or half-European descendants, who are more resistant to disease than the pure-blooded natives.

Mr. Linton's account of the Marquesans is restricted to their material culture, and other features having been dealt with elsewhere, only a short summary is given of social organisation and religion. But houses, canoes, stone artifacts, weapons and implements, clothing and ornament are described in detail and illustrated by forty-four full-page plates and eleven figures in the text. The few local differences in the islands are set out in a comparative table, which is repeated in greater detail to exhibit the relations of the Marquesan material culture to that of other Polynesian groups. Samoa and Tonga are found to have a closer cultural agreement than any other two localities. The Marquesas and New Zealand are almost equally close. The Society Island culture comes between the Samoan-Tongan and the Maori-Marquesan. Hawaiian culture resembles the Maori-Marquesan on the material side, but is more nearly related on the non-material side to the Society Islands and Western Polynesia.

The author gives the following hypothesis of the historic distribution of races and culture in the Pacific. The first arrivals in Central and South-east Polynesia were Negroid and Melanesian rather than Polynesian in culture. They settled in Tonga, Samoa, the Cook, Society, Austral, and Tuamotu groups. They did not reach the farther islands and came from Melanesia, probably Fiji. The next comers

[1] "The Material Culture of the Marquesas Islands." By Ralph Linton. Memoirs of the Bernice P. Bishop Museum, vol. viii. No. 5 (Bayard Dominick Expedition. Publication No. 5) Honolulu, Hawaii, 1923.

"The Moriors of Chatham Islands" By H D. Skinner Memoirs of the Bernice P. Bishop Museum, vol. ix. No. 1. (Bayard Dominick Expedition. Publication No. 4.) Honolulu, Hawaii, 1923.

"Marquesan Somatology with Comparative Notes on Samoa and Tonga." By Louis R. Sullivan. Memoirs of the Bernice P. Bishop Museum, vol. ix. No. 2. (Bayard Dominick Expedition. Publication No 6.) Honolulu, Hawaii, 1923.

were of the Caucasic race and came by way of Micronesia from Indonesia to Samoa. They produced a hybrid race and the south-east Polynesian type of culture. A fairly pure group of this Caucasic race reached the Marquesas and, mixed with the Negroids, arrived in Easter Island. Another group passed through Melanesia and modified the culture of the Eastern Melanesian Islands. The last comers were the Indonesians, who entered by way of Micronesia and thence passed to Tonga and, mixed with earlier people, to Hawaii. In Samoa they were resisted for a time by the earlier population, which in Niue survived into historic times. From Western Polynesia the Indonesians colonised New Zealand, spread over South-east Polynesia and reached the Marquesas. Later movements from the west have modified the culture and rendered it extremely complex.

In Mr. Sullivan's study of Marquesan, Samoan, and Tongan somatology, the distinctions of race are elaborated in a series of anthropometric tables based upon the examination of 84 adult men and 74 adult women of the Marquesan islands. These were compared with his similar studies of Samoans and Tongans in other papers. His estimate of the physical condition of the people has been already quoted. The measurements show the Marquesans to be "tall, with long, wide head, a high, wide face, and a high, wide nose. All of the dimensions of the head and body are large, indicating their massive size. They are on the verge of brachycephaly. But one cannot be sure that the heads are wholly undeformed."

According to Mr. Sullivan the "Polynesians" of the Marquesas, Samoa, and Tonga are a mixed people. He finds in them three racial types. In addition to the Polynesian population there is a second type resembling the Indonesian peoples of Malaysia, and a third extremely short-headed element. He has dealt mainly with the Polynesian and Indonesian types. The former are taller, with longer heads, higher faces, narrower noses, perhaps straighter hair, more beard and body hair, and lighter skin than the Indonesians. They appear thus to be the Caucasic people of Mr. Linton's hypothesis.

Mr. H. D. Skinner's monograph on the Morioris is exhaustive as regards the material culture of the people and their relation to the Maoris and other Pacific islanders. It is prefaced by an admirable summary account of the bodily and mental characteristics of the Morioris, their language, social organisation, and religion. This is derived partly from the very scattered accounts of earlier writers, but has been considerably extended by Mr. Skinner's own investigations in the Chatham Islands. As in the Marquesan papers, the illustrations are an important feature. The paper before us contains thirty-six figures in the text, and thirty-five full-page plates.

With regard to the origin of the Moriori, Mr. Skinner gives a summary of their own traditions as recorded by Shand and the Maori version of Whatatoro, which was accepted as accurate by Mr. Percy Smith and Mr. Elsdon Best. The Moriori account seems to show at least two principal immigrations from unknown lands, the last of which took place, if the genealogies may be relied upon, about thirty generations ago, or about A.D. 1175. According to the Maori account they were a portion of the original inhabitants of New Zealand, called Maruiwi, who had been driven by a storm while fishing from a great land south-west of New Zealand. Mr. Skinner points out the inherent improbabilities of this story: the presence of women in a fishing party, the food required for a thousand-mile journey, and the impossibility of people in the cultural stage attributed to the Maruiwi possessing ocean-going canoes. The Maruiwi, moreover, were the physical antitheses of the Moriori. They were tall, thin, dark-skinned, with flat noses and straight hair, whilst the Moriori are short and bulky, brown-skinned, with prominent noses, and hair often waved and sometimes frizzy. The Maruiwi lived wholly on forest produce, and knew nothing of fine weaving, but the Morioris had a traditional knowledge of cultivated plants, and made fine matting. Not one of the Moriori weapons described by Mr. Skinner is mentioned in the account of the Maruiwi.

Mr. Skinner's final remarks are important. The craniology of the Moriori shows close relationship with the Maori, and some social features are identical. The language is divergent, but Mr. Skinner suggests a likeness to the Kaitahu of South New Zealand. The evidence of material culture is decisively in favour of a Maori origin, though some evidence appears of a likeness with Easter Island and Melanesia in the conception of human and animal forms in art, and in some hooks and adzes.

Taken as a whole these three studies considerably increase our knowledge of the Polynesians. But their conclusions have yet to be compared with the evidence of language, sociology, and religion.

SIDNEY H. RAY.

Ancient and Modern Arithmetic.

THE special object of the papers referred to below [1] appears to be to establish one main thesis, namely, that there was no such thing as arithmetic in our modern sense before the sixteenth century. To quote the author's words: "Modern arithmetic, which is a peculiarly Western invention, is yet barely 400 years old. Prior to 1500, and during some 3500 years of unbroken mathematical continuity and evolution, the science and art of calculation differed absolutely from anything in vogue with us."

The sole direct argument by which the author supports this thesis is the occurrence, in two particular treatises on arithmetic which he quotes, of a method of multiplying two digits to which he applies the general term "calculation by deficients." The anonymous English author of "An introduction for to lerne to recken with the pen, or with the counter, accordying to the trewe cast of algorism, in hole numbers or in broken, etc," written in 1546, multiplies 7 by 5, and for this purpose substitutes $(10-3)$ for 7, arriving at the result by a process which is equivalent to $7 \times 5 = (10-3)\,5 = 50 - 15 = 35$. The Frenchman Oronce Fine (not "Finé"), whose work was first published during the years 1530–32 (not 1525), uses an even more roundabout process equivalent to $7 \times 5 = (10-3)\,(10-5) = 15 + (7-5)\,10$ [or $(5-3)\,10$] $= 15 + 20 = 35$.

Now this "complementary" method of multiplication (as it has been called) is a familiar item in most histories of mathematics: there is nothing new in Prof. Brockwell's discovery. He says, indeed, that the anonymous English treatise "appears to have been entirely overlooked by all the more recent writers on the history of mathematics both in Europe and America"; but, if he had referred to David Eugene Smith's "Rara Arithmetica" (1908), he would have found (p. 244) a notice of this anonymous work and of the later edition of it published in

[1] "The Transition from Ancient to Modern Arithmetic, I II." (reprinted from *The Teachers' Magazine*, Montreal, Dec. 1923 and April 1924); "Calculation by Deficients (a remarkable aspect of the Evolution of Arithmetic)," a paper read before the American Oriental Society, April 23, 1924; by the Rev. C. A. Brodie Brockwell.

1574. He would also have found in the same "Rara Arithmetica" (p. 76) a case of "complementary" multiplication from an earlier treatise (Huswirth, 1501). But the strange thing is that our author seems to infer from these cases that before 1546 such multiplications were never done in any other way, that "none of our tables of arithmetic had been invented as recently as 1500 A.D.," that "our multiplication-table had not been invented," and that, "while men could multiply, as we do, up to five times five by the fifteenth century, they could not go beyond this." There is, indeed, no trace of multiplication-tables in Egyptian records, but the Babylonians had not only multiplication-tables but also tables of divisions, of squares, of square roots and cube roots. The Greeks and Romans certainly had multiplication-tables: there is one in Nicomachus (about A.D. 100) and in Boetius (about A.D. 500), and they must have been used much earlier. There are also multiplication-tables in a treatise on abacus-reckoning by Bernelinus (about A.D. 1020), in the "Liber abaci" (1202) of Leonardo of Pisa, and in Widman's Arithmetic (1489). So much for the multiplication-table. (The fact that Pepys had such trouble in learning the multiplication-table is of course no proof that schoolboys and others had then (1662) only just begun to use it, and that it was then little more than 100 years old; other great men have been without a gift for arithmetic.)

The story of the arithmetical operations is similar. Eutocius (5th century A.D.), in his commentary on Archimedes, gives various long multiplications differing from ours only in the arithmetical notation used. Theon of Alexandria (4th century A.D.) divides 1515° 20′ 15″ by 25° 12′ 10″ and extracts the square root of 4500° in degrees and sexagesimal fractions by a procedure which, allowing for the difference of notation, is the same as ours. Long multiplications in the Treviso Arithmetic (1478) are done in a way exactly equivalent to our method, and in some cases they are written out in exactly the same form. So with long divisions, which appear, in the same form as with us, in an Italian MS. of about 1460 (see D. E. Smith, *op. cit.* p. 462), and in printed works by Calandri (1491) and Luca Paciuolo (1494). It is true that some ancient systems of numerical nomenclature expressed certain numbers on a subtractive principle: cf. the Roman *undeviginti* and *duodeviginti* for 19, 18, etc., and the numeral signs iv., cxc., etc. The Babylonians, too, used the same principle commonly, if not so systematically: *e.g.* we find 118 written as 120 *minus* 2, and 27 as 30 *minus* 3. Possibly the "complementary" multiplication owes its origin to this feature of the Roman numeral system. But there seems to be no trace in India, Arabia, Egypt or Greece of the "complementary" method of multiplication.

Such being the facts, few, we imagine, will agree that arithmetic was dominated continuously from the earliest times to the sixteenth century by "calculation by deficients," and that our modern arithmetic was a Minerva-like offspring of that century.

Prof. Brockwell finds indirect evidence for his theory in a multitude of allusions in literature which hint at odd systems of numeration and curious processes of calculation. He draws mostly from Hebrew and Biblical sources and states a number of interesting puzzles, *e.g.* "Why from time immemorial had *aleph*, the first letter of the Hebrew and Phœnician alphabet, the index both of 1000 and of 1?" "Why, when speaking of the seven days of the first creation story, did the mediæval Hebrew exegetes describe them as seven thousand days?", and so on. These puzzles may no doubt offer a considerable field for further research into primitive arithmetic.

We may observe incidentally that our author assigns Philolaus to the 5th century A.D. (instead of B.C.), making Isidorus, Bishop of Seville (A.D. 560–636), "a little over a century later." He also speaks of Proclus, the Neo-Platonist, as "the Egyptian mathematician"!

University and Educational Intelligence.

LIVERPOOL.—Applications are invited for the Derby chair of anatomy, the duties of which post will begin on January 1 next. The latest date for the receipt of applications by the registrar is October 1.

A DEMONSTRATOR is required in the department of mathematics of the City and Guilds (Engineering) College, South Kensington. The latest date for the receipt of applications and statement of qualifications, by Assist. Prof. Klugh, at the College, is August 30.

APPLICATIONS are invited for two research assistantships in the Physical Laboratory of the University of Toronto. Candidates must be university graduates with special training in physics. Applications should be sent to Prof. J. C. McLennan at the University.

APPLICATIONS are invited for the professorship of surgery in the University of Otago, New Zealand. Particulars of the appointment and a form of application may be obtained upon written request to the High Commissioner for New Zealand, 415 Strand, W.C.2. The completed form must be returned by August 31.

As part of the Vacation Course for Teachers arranged by the West Riding Education Committee at Bingley, Mr. Wilfred Mark Webb, general secretary of the Selborne Society, gave a lecture and demonstration on August 12 dealing with "The Cinematograph in Education." He considered two aspects of the subject, namely, the use of moving pictures in the ordinary curriculum in connexion with the definite teaching of various subjects in which it is recognised that they may be helpful, and during out-of-school hours for broadening the pupils' outlook. He strongly emphasised the need at present of superseding the lantern slide only when it is advisable to represent movements which are going on, or can be introduced as an improvement upon the still picture, and even upon the blackboard, in the building up of drawings, diagrams, or maps, or by making models work upon the screen.

IN continuation of the policy of training aircraft apprentices in the skilled trades of the Royal Air Force, two examinations for the entry in January next of more than 500 boys, between the ages of 15 and 16½ at the time of entry, will be held on October 17 and November 4 respectively. The closing date for the receipt of completed forms of application for the first examination, which is an "open" competition conducted by the Civil Service Commissioners, is August 28, and for the second "limited" competition, which is carried out by the Air Ministry in conjunction with the local education authorities, the forms of nomination must be received in the Air Ministry by October 7. For the former, forms of application can be obtained from the Secretary, Civil Service Commission, Burlington Gardens, London, W.1. For the latter, nominations can be obtained through headmasters of schools, Advisory Committees for Juvenile Employment, the Boy Scout Association, and officers commanding Territorial Cadets.

A "FEDERALISATION" of the London Institute of Historical Research in the interests of students in all British universities has for some years past been advocated by Sir Richard Lodge, and he was able to announce at the universities' conference of May 10 that the idea had been adopted by the Council of the Institute. In America a movement of a similar character has been set on foot with the object of utilising in the future more fully than in the past the material and scholarly resources at Washington for purposes of graduate study and research by students from all parts of the United States. The attitude of the leaders of the movement is summed up in a phrase used by Prof. Leuschner of California in a paper presented last November to the Association of American Universities: "Every graduate school should extend to Washington." Prof. Leuschner went on to say that American graduate students move about more and more freely and that this development is not merely due to the advice of deans and professors but is increasingly due also to the scholarly initiative of the students themselves. He admitted that this freedom is "impeded at times by a certain *local pride or provincialism of departments* and their representatives, who fear loss of students and of prestige by carrying it to its logical conclusion." He stated, however, that it is fully recognised that few universities can undertake distinguished work in many branches. On the important question whether fellowships are allowed to operate as impediments to free migration, he went no further than to say that he hoped no fellowships are being maintained that are not primarily established for the fullest enjoyment of great opportunities in the field of scholarship and research.

THE report of the Imperial Education Conference Committee on the use of the cinematograph in education has been issued recently (H.M. Stationery Office, 1924. 1s. net). Not the least part of the value of the report lies in the extracts from memoranda submitted by inspectors and secretaries of education who have watched experiments, by headmasters who have introduced films into their schools, and by teachers who have actually used the cinematograph in teaching. The positive conclusions reached are those which are fairly obvious: namely, that the cinematograph can be of real value as an adjunct to present methods, and that it should be recognised as part of the normal equipment of educational institutions, especially for use in teaching nature study, geography, science, and industrial processes. It is noteworthy that those who have had practical teaching experience with the instrument are much more enthusiastic than are others. Though nothing is said in the report, opinion seems to be swinging round to the view that the classroom rather than the picture theatre is the place for educational work with the film. Importance is rightly attached to the fact that projectors and screens now exist quite suitable for use in a classroom, and that the technical difficulties which used to prevent their use have disappeared, though the difficulty of cost remains. The absence of suitable films is, however, referred to again and again. One hint is given, that films should not take longer than ten minutes to run through; the writers of this note would say five; but this does not carry us very far. The crux of the problem is reached when the Committee says that the films "which are procurable are unco-ordinated and do not fit in with one another or with the ordinary school syllabuses." It is the well-thought-out teaching syllabus which dominates the situation, and film producers who desire to get the patronage of, or to help, teachers must take account of it.

Early Science at the Royal Society.

August 26, 1663. It being related by Mr Oldenburg the secretary, that he had been desired by Monsieur Ludolf, councillor of the duke of Saxe-Gotha, to procure from the society, for a domestic of that prince, who was to be sent into Egypt and Ethiopia, some instructions of inquiries fit to be made in those parts; the society desired Mr. Boyle, Mr. Henshaw, and other members to draw up some queries for that purpose. [Among these was one, "Whether, tho' the plague be never so great before, yet on the first day of the river's increase, the plague not only decreaseth, but absolutely ceaseth; not one dying of it after?"]

August 27, 1662. Upon the occasion of the manuscript philosophical books, which were presented to the society for their examination, and received a good character from those members, who had read them, it was ordered, that no books presented to the censure of the society shall receive approbation from them; but only, if the society think fit to refer such books to one or more of the fellows, esteemed by them competent judges thereof, that the report made thereof to the society by such fellows, may be communicated to the authors of the books thus presented; and that it may be signed by one of the secretaries.

August 28, 1661. Dr. Clarke read a paper entituled "Observations on the humble and sensible plants in Mr. Chiffin's garden in St. James's Park, made August 9, 1661."—Mr. Boyle presented the book which he had published since the order was made, that every member, who should publish any book, should give one to the society's library.

August 29, 1662. In the afternoon of this day the president and council, with other members of the society, waited on the king, to return him the thanks of the society for the patent of their establishment. The president made a speech to his majesty [This extols the king's grace and favour, and expresses "our firm resolution to pursue sincerely and unanimously the end—the advancement of the knowledge of natural things, and all useful arts, by experiments."]

1678. His grace the Duke of Norfolk being present at this meeting, renewed the declaration of his gift to the Society of the Arundelian library; and gave his consent and direction for the removal thereof: and that they should have liberty to exchange such books thereof, as were duplicates, or which they should think not so proper for their use, for others of equal value. His grace added, that Sir William Dugdale had presented him with a catalogue of books of heraldry, as he in the name of the heralds had desired. But upon perusal of the same finding many of them to be such, as did not so properly belong to the business of heraldry, the duke was desirous, that Sir Robert Redding and Mr. Evelyn would peruse the said catalogue, and consider what were most proper for the college of heralds, and what might be more proper for the use of the Society, and to moderate and adjudge the matter between the Society and college. But it was his grace's further pleasure and desire, that in case the Society should be dissolved (which it was his desire and hope they never would be) the said library might revert to his heirs. The Society by the mouth of the president returned his grace their most humble and hearty thanks for this his truly noble present: and ordered Mr. Hooke to take care, that the determination of the matter between them and the college of heralds might be made with all convenient speed; and that thereupon the books should be forthwith removed to Gresham College.—Mr. Henshaw moved, that a fair catalogue of them might be made, to be delivered to the duke to remain in his grace's custody.

Societies and Academies.

PARIS.

Academy of Sciences, July 21.—M. Guillaume Bigourdan in the chair.—A Lacroix: The grained eruptive rocks of the archipelago of Kerguelen. Complete analyses of twelve rocks collected by M. E. Peau; including nepheline syenites, phonolite, quartziferous syenites, biotite granite, trachyte, and eucrite. These rocks suggest the existence of much older volcanic formation than the lava constituting the main formation of the archipelago.—Paul Appell: The movement of a heterogeneous fluid mass, submitted to the mutual attraction of its particles, round its centre of gravity.—A Haller and (Mme) P. Ramart: The preparation of the monoalkylpulegones.—Ch. Moureu, A. Lepape, and H. Moureu: The radioactivity of some thermal springs of Madagascar (the Antsirabe basin) and of Reunion. Determinations of the radium emanation in the gases from seventeen springs in Madagascar and eight in Reunion have been made. Minute amounts of thorium emanation were detected in one spring only.—Gabriel Bertrand and Hirosi Nakamura: The comparative physiological importance of iron and zinc. Experiments on young mice show that a deficiency of zinc in the food produces a more marked effect on growth than a deficiency of iron.—Charles Rabut: The sounding of dams and chimneys—E. Mathias: The terminal forms of flashes of lightning.—M. de Séguier: The isomorphisms of certain groups—Emile Jouguet and Maurice Roy: The paradox of d'Alembert in the case of compressible fluids.—J. Guillaume: Observations of the sun made at the Lyons Observatory, during the fourth quarter of 1923. Observations were made on 56 days, and the results are given in three tables showing the number of spots, their distribution in latitude, and the distribution of the faculæ in latitude.—R. Jarry-Desloges: Contribution to the study of the disaggregation of the southern polar-cap of the planet Mars—Charles Platrier: Contribution to the study of various physical phenomena by transformation of linear differential equations into integral equations.—L. Dunoyer and P. Toulon: A remarkable property of the positive column of the mercury arc. Action by the influence of external sheaths.—L. Vegard: The luminescence of solidified gases and their application to cosmic problems.—G. Bruhat and M. Pauthenier: The absorption of ultra-violet rays by carbon bisulphide—J. Errera: The solid state looked at from the electric point of view; dispersion in the Hertzian domain.—J. Escher-Desrivières: Polonium carried down by silver chloride. A quantitative study of the removal of polonium from solutions by precipitation of silver chloride, the solution containing variable amounts of hydrochloric acid, sodium chloride, and potassium chloride.—J. H. Le Bel: Small variations in the heat disengaged by various specimens of radium bromide. A specimen of radium bromide, placed in a Dewar tube in a cellar 20 metres below ground, gave a perfectly steady temperature rise, which, however, once or twice a month, showed a slight fall. A second apparatus, placed under the same conditions, indicated the same minima at exactly the same times. The phenomenon appears to have its origin outside the radium, and it would be desirable to repeat the experiment elsewhere, preferably in America.—James H. Brennen: The carrying down of polonium by colloids. The colloid is precipitated by an electrolyte, and the amount of polonium in the precipitate determined. It depends on two factors; the time that the polonium has been in contact with the colloid before precipitation and the time that the precipitate has been allowed to stand before filtration. Colloidal silver or ferric hydroxide retains practically all the polonium (97 to 98 per cent.).—D. Yovanovitch: An apparatus for measuring the heat disengaged by radioactive bodies.—Jean Thibaud: The γ-rays of very great quantum and the photo-electric origin of the natural β spectrum of radium.—André Job and Guy Emschwiller: The photochemical limit and the energies of linkages—H. Gault and F. A. Hessel: The pyrogenic dissociation of hexadecane. The apparatus used has been described in detail in an earlier communication. Analyses of the gas and liquid produced are given for seven temperatures varying between 390° C. and 815° C.—P. Langlais and J. Goby: Contribution to the study of essence of iris In addition to the constituents already known, the presence of six saturated fatty acids has been proved, caprylic, pelargonic, capric, undecylic, lauric, and tridecylic acids.—Marcel Delépine: The transformations of the pinenes by acids.—Max and Michel Polonovski: The degradation of the hydrogenated derivatives of eserine.—Pastureau and H. Bernard: Ethyl-trimethyl glycerol.—Alphonse Mailhe: The decomposition of animal wax. A study of the destructive decomposition of beeswax in the presence of catalysts.—Pierre Viennot: The boring of Abatilles, near Arachon.—Emile Belot: The application of the principles of the dualist cosmogony and of isostasy to the study of various geological problems.—J. Cabannes: The transparency of the atmosphere.—J. Liouville: The corals harmful to the trawlers of Morocco.—Mlle. Y. Ménager: The use of sodium chloride as a standard in analyses of sea-water.—René Souèges: The embryogeny of the Typhaceæ. The development of the embryo in *Sparganium simplex*.—Mme. Paul Lemoine: The distribution of the calcareous algæ (Corallinaceæ) according to depth in the Mediterranean.—André Mayer and L. Plantefol: The water exchanges of mosses with the atmosphere.—André Charriou: The absorption of potash by humic acid.—F. Heim and R. Audubert: The agglutinating power and coagulating power of coagulation agents towards rubber latex.—Ladislas Smolik: The influence of electrolytes on the total surface of the elements of the soil.—R. Fosse, Ph. Hagene, and R. Dubois. The gravimetric estimation of cyanamide as xanthyl-urea.—Jules Amar: The preservation of living tissues. The solution proposed contains sodium phosphate, 3·0, sodium bicarbonate, 3·0, and sodium chloride, 2·0 in water 1000. Advantages are claimed for this solution over the solutions of Locke, Ringer, and Biedermann.—Auguste Lumière and Henri Couturier: The toxicity of normal sera.—L. Mercier: *Geomyza sabulosa*, a microdiptera with reduced wings; loss of the faculty of flight in this species as a result of the drosophilian process.—G. Athanassopoulos: The geographical distribution of fresh-water fishes in Greece.—Mlle. Kostritsky, Mme. Toumanoff, and S. Metalnikow: *Bacterium tumifaciens* in the grub of *Galleria mellonella*.—M. Weinberg and A. R. Prévot: The use of anatoxins for the preparation of antigangrene sera.— — Paillot: The etiology and epidemiology of *grasserie* (a disease of the silkworm).—Mme. Jean François-Pérey: The influence of sunlight on the development of a soil protozoa, *Colpoda cucullus*.

SYDNEY.

Royal Society of New South Wales, May 7.—R. H. Cambage: Presidential Address, Australian resources of liquid fuels. Mr. Cambage expressed the opinion that it is imperative the most intense research should be undertaken to devise, on commercial lines, some method of treatment of coal by which a very much higher percentage of liquid fuel may be extracted or manufactured from this commodity than is obtained by present-day methods in connexion with coking, or that some other process, such as that of com-

bustion of finely divided particles, may be perfected, by which the power may be obtained direct from coal without converting it into oil.

June 4.—Dr. C. Anderson, president, in the chair.—C. **Hedley**: Differential elevation near Sydney. Two raised terraces of marine erosion situated on the ocean side of North Head are described. The highest is elevated about thirty feet. This pair of raised beaches again appears three miles to the westward. But there the highest is only about eight feet instead of thirty above the present level of erosion. The conclusion is drawn that this differential movement is the result of a fold or earth wave at least six miles wide and thirty feet high.—W. G. **Woolnough** and J. L. **Somerville**: A contribution to the geology of the Irwin River Valley of Western Australia. Two strongly unconformable Pre-Cambrian formations are distinguished. The well-developed Permo-Carboniferous system is zonally subdivided chiefly on a lithological basis The glaciology is described in some detail. Reasons are advanced for regarding as Cainozoic (Plateau Beds) much of the formation previously described as Jurassic. Well-marked step-faulting towards the Indian Ocean is indicated. The probability of the existence of economically important deposits of coal and salt is considered remote.

Linnean Society of New South Wales, May 28.—E C. **Chisholm**: Eucalypts of the Blue Mountains and their defined areas. Thirty-four species of Eucalypts have been observed by the author on the Blue Mountains and the distribution of those species in this region is recorded.—J. R. **Malloch**: Notes on Australian Diptera. No. ii. Notes on a number of species in the subfamilies Anthomyiinæ, Phaoniinæ, and Fanniinæ. Nine species are described as new, and a key is given to the three Australian species of Hylemyia.—R. **Veitch** and W. **Greenwood**: The food-plants or hosts of some Fijian insects. Part 2.—T. **Steel**: Observations on *Helix aspera* in Australia. This shell is usually considerably smaller and always lighter in weight in various parts of Australia and in New Zealand than is normally the case in Europe. It is identified with the var. *tenuior* Shuttl. Other varieties found near Sydney are vars. *depressa* Paul and *puncilulata* Bandon. A specimen distinctly approaching the cornute form was also found, but no sinistral examples have been met with. Marked diminution in size of the shell in the adult, following prolonged, dry, hot conditions, is noted.

June 25.—Mr. R. H. Cambage, president, in the chair.—W. Docters **van Leeuwen** and H. H. **Karny**: Two new thrips-galls and their inhabitants from New South Wales. Descriptions of the occurrence of *Euoplothrips bagnalli* on *Randia chartacea*, and of *Cryptothrips* (?) *intorquens* and *Euoplothrips bagnalli* on *Smilax australis*.—A. M. **Lea**: On some Australian Scarabæidæ. The paper deals with cockchafer beetles; notes on various species are given, and thirty-eight species, mostly of the subfamily Melolonthides, are described as new.—C. **Iredale**: Results of Roy Bell's Molluscan Collections. The collection here studied is only one of half a dozen made at important zoological points on and about the Australian coast for the purpose of elucidating geographical problems. The Twofold Bay Mollusca agree in species and genera with those from Sydney, but entirely lack a northern Australian element, and show a small percentage of southern Australian forms, a number of additions of such species being made to the N.S.W. fauna. A few new species were secured, while the fine series, in perfect condition, of many species have already furnished important results, such as the viviparous nature of some Turritellid molluscs and the polyphyletic nature of the Minolioid group of Trochoids. A most important feature of a few dredgings made in 50-70 fathoms is the great resemblance between the molluscan fauna at present living at that depth and the fossils of the Upper beds of the Muddy Creek deposits.

VIENNA.

Academy of Sciences, June 12.—L. **Lammermayr**: On the dispersal of warmth-loving plants in the Mur district. Researches on the light- and climate-relations of the stone pine.—F. **Ris**: Odonata, describing 16 species, two from the White Nile previously undescribed.—H. **Spandl**: Freshwater Amphipodes including those of the Caspian Sea and of Lake Baikal and of subterranean waters, and a discussion of the migration of marine Amphipodes into fresh water.—V. **Brehm**: New Entomostraca from the Handel-Mazzetti expedition to China.—E. **Dittler** and A **Kohler**: Experimental researches on disentangling potassium-sodium felspars. Reactions of this sort have been recognised for KCl – NaCl, but so far little has been done on the silicates. Diffusion in the solid condition can be shown to take place in thin sections. Perthite was heated in an electric resistance furnace for 500 or more hours to a temperature of about 1000°. After heating, the difference in the refraction of the two components of perthite had completely vanished. The capacity of albite and orthoclase to diffuse into each other at high temperatures, and whilst still solid, is favoured by the circumstance that these felspars can form mixed crystals.

June 20.—**Kerner-Marilaun**: Solar-climatic temperatures in palæozoic antiquity.—H. **Handel-Mazzetti**: Plantæ novæ Sinenses. More new plants from China, varieties and species of Juniper, Camellia, Lobelia, and Leontopodium.—L. **Kolbl**: The tectonic of the granite peaks in the High Tauern.—R. **Kremann** and R. **Gruber-Rehenburg** of Graz: Electrolytic conductivity in molten metal alloys, 6th communication. Researches on the electrolysis of some copper alloys—CuZn, CuSn, CuAg, CuAl. In Cu-Sn a small displacement of Cu to anode, of Sn to cathode; a somewhat greater displacement in Cu-Al, of Cu to cathode, Al to anode.—R. **Kremann** and O. **Benda**: Electrolysis of Ag-Pb alloys, Ag to cathode, Pb to anode.—R. **Kremann** and H. **Drazil**: On the influence of substitution in the components of binary solution equilibrium, 45th communication. The binary phase-diagram of benzhydrol with phenols and amines.—E. **Müller**: Calculation with Falt-products in its application to figures of the second degree in space. A new method of calculation having the advantage of great brevity, particularly with complex quantities.

Official Publications Received.

Malayan Agriculture, 1924. Handbook compiled by the Department of Agriculture, F.M.S. and S.S. (British Empire Exhibition edition.) Pp. v+301+iv. (Kuala Lumpur: Department of Agriculture.) 1*s*.

Agricultural Research Institute, Pusa. Bulletin No. 152: The External Morphology and Bionomics of the commonest Indian Tick (*Hyalomma ægyptium*) By Mohammad Sharif. Pp 25+5 plates. (Calcutta: Government Printing Office.) 1 rupee.

Report on the Administration of the Meteorological Department of the Government of India in 1923–24. Pp. 16. (Simla: Government Press.) 2 annas.

Union of South Africa: Department of Agriculture. 9th and 10th Reports of the Director of Veterinary Education and Research, April 1923. Pp. 823. 10*s*. Reprint No. 18. Phosphorus in the Live Stock Industry. By Sir Arnold Theiler, Dr. H. H Green, and Dr. P. J. Du Toit. Pp. 47. 6*d*. (Pretoria. Government Printing and Stationery Office.)

Forestry in Brunei and Labuan: a Statement compiled for the British Empire Forestry Conference, Canada, 1923. By G. E. S. Cubitt. Pp. 8. (Singapore: Government Printing Office.)

Federated Malay States. Report of the Secretary for Agriculture, Straits Settlements and Federated Malay States, for the Year 1923. Pp. 10 (Kuala Lumpur.)

United States Department of Agriculture. Department Bulletin No. 1223: The European Elm Scale in the West. By Frank B. Herbert. Pp 20. (Washington: Government Printing Office.) 10 cents.

Jamaica. Annual Report of the Department of Agriculture for the Year ended 31st December 1923. Pp. 39. (Kingston, Jamaica: Government Printing Office.)

Board of Education. Regulations for Whitworth Scholarships 1925. 52nd edition. Pp. 15. (London: H.M. Stationery Office.) 2*d*. net.

The Development of the Hokkaido Imperial University. Pp. 79+3 plates. (Sapporo, Japan: Hokkaido Imperial University.)

SATURDAY, AUGUST 30, 1924.

CONTENTS.

Editorial and Publishing Offices :
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.

Editorial communications should be addressed to the Editor.
Advertisements and business letters to the Publishers.

Telephone Number: GERRARD 8830.
Telegraphic Address: PHUSIS, WESTRAND, LONDON

The China Indemnity Bill.

CHINA is perennially a land of contrasts. This holds not merely in material things that strike the eye—such as nodding the head to say no, shaking it to say yes; putting on the roof of a house before laying its foundation; ending the book on the page where ours begins—but in spiritual things also, such as being content with an ethical system rather than a religion, but making its practice an inalienable part of the inner man. Nor does the spirit of contrast end here. It affects, to his surprise, the foreigner, and in particular the Englishman, who lives and works in China. Day by day in business matters he is inconvenienced by Chinese unpunctuality, by their waste of time, their avoidance of definite statement, their shrinking from responsibility, their superstitions; but when challenged as to the outcome of it all, he acknowledges, as recently a Consul-General did at a social gathering, that though he is at times annoyed or angry with them, yet when he thinks of the Chinese, he remembers mainly their honesty, their habitual courtesy, their good humour, so that liking and even affection becomes his ultimate attitude.

Another aspect of this spirit is presented by the *Times* of August 9, which includes both an article from a correspondent entitled "A Way to help China" and a leader on "Chinese Problems." The latter, while indicating how important to British trade would be even a slight improvement in China's present political conditions, supports the views expressed by its correspondent as to the value of co-operation, and declares "the line of action he proposes will lead to success. Others will mean confusion and failure." The contrast seen here amounts to this, that while our contemporary, by means of letters from its well-informed correspondent in Peking, has continuously pointed out the increasing antagonism, amounting even to danger to life, which foreigners at present experience in China, the article in question, which advocates as its one aim the cultivation of Anglo-Chinese friendship, is commended as being "an admirable and directly practical way of making British influence felt in China in its most fruitful form."

We now turn to the way there proposed for helping China: to devote to education practically the whole—or say nine-tenths—of the British quota of the Boxer Indemnity Fund, amounting to 400,000*l.* a year and payable until 1945. The article first directs attention to certain defects in the China Indemnity Bill, which in the House of Commons has passed its second reading and the report stage: its purposes are as yet indefinite, but an amendment, tabled in fact by members drawn from all three political parties, proposes that these

purposes, like those adopted by Japan and the United States in the same matter of indemnity remission, shall be defined as "educational or cultural." This amendment will probably be adopted, for Great Britain, pressed by both the United States and Japan in the Chinese markets, cannot afford to take a lower line, even in name, than they. In that case, the Advisory Committee which the Bill proposes to set up to advise the Foreign Secretary will have to be constituted accordingly, and should contain not only persons having knowledge and experience of educational and medical work, but also, in view of the great and increasing importance of female education, a Chinese woman, who, like her compatriot proposed to be included on the Committee, should favourably impress Chinese opinion by appropriate scholarship and educational experience.

To us, the article is of particular interest, because it boldly states that there is only one way to help China permanently and radically: that is, by education, and, moreover, an education which includes science. This assumes that no ground more favourable than education exists for the promotion and exercise of friendly relations between British and Chinese. The field includes, of course, such institutions and activities as universities, colleges and medical schools, and the promotion of scientific research in them and in related institutions. If the right method be adopted, it will be possible to bring home to the Chinese, who are both a shrewd and a responsive people, the value to China of including in the curriculum of higher education, as well as the study of science, that of letters, and of making it possible for Chinese youth to acquire some of the characteristics which mark the traditions of Public School education in England at its best—its spirit of initiative, of independence of character, of the desire for corporate well-being and voluntary service.

As there is only one way of radically helping China, so there is only one method of making this help permanent. The method is that of co-operation. This should be full and continuous, alike in formulating any general plan and in carrying it out in detail. To ensure that co-operation should be of this kind, at once real, and personal, and officially recognised, an indispensable condition is that an admixture of Chinese and British members should be an element in the constitution of the Foreign Office Advisory Committee, the local Committees in China, and the Boards of Management of all aided institutions, whether under Chinese or British management. This principle has been initiated and commended by the foresight of the Foreign Office in arranging for the inclusion on the Advisory Committee of "at least one citizen of the Republic of China." It remains to extend the principle and to apply it comprehensively. Local Education Committees, which would act under such general regulations as the Advisory Committee will draw up, might be formed in each of China's eighteen Provincial capitals, the Chinese and the British Chambers of Commerce there each nominating one-third of the members, the remaining third being partly *ex officio* and partly co-opted or nominated. In the case of Provinces not having a British Chamber of Commerce, it would not be difficult, by nomination or co-optation, to provide the necessary third, since not more than four members at most would be required. A similar method might be employed in providing the admixture of representatives upon Boards of Management of higher educational institutions, wherever situated.

The Advisory Committee as the central authority would itself deal with central institutions such as universities, and with central activities such as medical work, scholarships, and Chinese students. As to these activities, it may be noted: that the Anglo-Chinese community, in all their representations to the British Government, have emphasised the high value of British medical work, of which they are rightly proud; that scholarships stand for the Chinese tradition by which learning opens the way to distinction and a career; and that Chinese expenditure on students, which would involve a Chinese Institute in London and a subsidised hostel, would tend, by means of mutual international intercourse and understanding, partly to open the world to China and partly to open China to the world.

If some Anglo-Chinese critic should object that the Chinese are not ripe for this equal hand of fellowship, the answer must be: first, that nothing is so uplifting as this gesture, provided it be continued long enough to show that it is real; and next, that not even the keenest detractor of China will deny the pervasiveness among her people of the characteristic of responsiveness. In this the Chinese are faithful to the teaching of their great sage, who, when Lao-Tzū challenged his great maxim, "Return good for evil," by asking, "With what then will you recompense kindness?" replied, "Recompense injury with justice, and recompense kindness with kindness."

This then is the way to help China: by cultivating, on both sides, the power to forget past injury; by enabling each nation to realise, through real and comprehensive co-operation in education, the best characteristics of the other; and by both fully accepting the truth that education, while it is always a venture of faith, holds, as no other movement does or can, the promise of the future.

Probability in Theory and Practice.

Assurances sur la vie: calcul des primes. Par Henri Galbrun. (*Traité du calcul des probabilités et de ses applications,* par Émile Borel. Tome 3: *Les Applications de la théorie des probabilités aux sciences économiques et biologiques,* fascicule 1.) Pp. vi+311. (Paris: Gauthier-Villars et Cie, 1924.) 35 francs.

Éléments de la théorie des probabilités. (Cours de la Faculté des Sciences de Paris.) Par Prof. Émile Borel. 3e édition revue et augmentée. Pp. vii+226. (Paris: J. Hermann, 1924.) 18 francs.

THE treatment of the subject of probability has developed in recent years mainly in its application to statistical research, and a large amount of work has been produced in attempts to express frequency distributions or correlation surfaces in mathematical terms or in measuring correlations and periodicity. In all these researches a practical object was to be attained, and there is almost unlimited scope for further development, but there still remain two classes of books on probability, which are exemplified by Prof. Borel's "elements" and Dr. Galbrun's actuarial text-book, which are but slightly connected with modern statistical work.

Prof. Borel's book is an excellent example of the treatment of probability which begins with games of chance and drawings from urns; it leads, through the approximations to factorials, to the normal curve of error. Prof. Borel discusses geometrical problems, shows the Gaussian treatment of errors of observation, gives Bayes's theorem, and then indicates the promised land of statistical investigation and tells us of some of the many fascinating places we may find there. But he leaves us, as it were, at Mount Horeb. The book is already known in its earlier editions as a good text-book on the subject within the limits indicated, but it ends at the point where many modern readers begin to be most interested.

Dr. Galbrun's subject, in some respects, begins after the interest of most readers has expired, for actuaries are bound to assume that they know the probabilities of death in order to make their calculations, and modern work has been mainly concerned in finding ways of interpreting the statistics on which the probabilities are based. Unlike the well-known English text-book writers, however, Dr. Galbrun attempts to bridge this gap, as he discusses the "errors" involved in some of the probabilities, endowments, and annuities with which he deals, and it is this part of his work that calls for special comment. In statistical work it is customary when calculating a coefficient of correlation, or a mean, or some other function, to set out after the result the probable error of the figure reached as some indication of the deviations that will arise in such cases, and the natural course would appear to be to adopt some such method in dealing with the values that an actuary requires. The matter is, however, more complicated than that of the means to which we have referred. There are not only the deviations that arise in the original statistics, but also, even if the true probabilities of death in the future were known, there would be deviations from these probabilities just as there are deviations from the probability of a head falling in a coin-tossing experiment where the probability is known. Dr. Galbrun does not attempt to give the probable errors of various actuarial functions, but makes estimates of what we may call a "safety margin" which will cover 99 per cent. of the cases. This margin could, in theory, be used as a loading to the premiums charged, but if it were used for small classes of business it might, by increasing the premiums, reduce the amount of business and so render the loading insufficient on the theory adopted. Any such loading must, in practice, be regarded somewhat broad-mindedly, and Dr. Galbrun has not striven after extreme accuracy but has used rather rough approximations.

We may now turn for a moment to some other points in the work. In many ways it follows familiar lines, with an unfamiliar notation, and the methods of working out the values of annuities, assurances, and premiums require little comment. We are a little surprised, however, to find that in the evaluation of certain complicated benefits, Lubbock's formula is used, so that a number of differences have to be calculated and the arithmetic becomes troublesome. The customary method in Great Britain of using Simpson's or some similar rule seems preferable. In a few cases, also, Dr. Galbrun spoils his effect a little by using an approximation when an accurate result presents no real difficulty, and we would willingly have given up some of the work on survivorship annuities for a concise treatment of apportionable annuities.

The book concludes with an appendix of thirty pages discussing mathematically the application of the law of error to the probabilities of death, and in this connexion we would throw out a word of warning. The probability of dying in a year at the ages that are most important in practice are small (they are less than 0·02 at ages under 55), and when the probabilities become relatively large, as in extreme old age, the number of cases becomes small. It follows, therefore, that the normal curve of error should only be used with a certain amount of discretion. Partly, no doubt, owing to the series in which the particular volume is included, and partly, possibly, owing to Dr. Galbrun's

personal inclination, his book is more mathematical and less clearly identified with the business of life assurance than the English text-books. The actuary on the Continent is less obviously the man of business than the actuary in England.

As we have seen, Prof. Borel indicates at the end of his book the interesting developments which lie outside its scope; it is not belittling, but appreciative, to say that there is room for similar development beyond where Dr. Galbrun's book ends, and that comparatively little has yet been done.

Electrical Instruments.

(1) *Electrical Measuring Instruments.* Part 1: *Commercial and Indicating Instruments.* By Dr. C. V. Drysdale and A. C. Jolley. Pp. 440. (London: Ernest Benn, Ltd., 1924.) 55*s.* net.

(2) *Electrical Vibration Instruments: an Elementary Text-book on the Behaviour and Tests of Telephone Receivers, Oscillographs, and Vibration Galvanometers.* (Engineering Science Series.) By Prof. A. E. Kennelly. Pp. xi+450. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1923.) 30*s.* net.

(1) IN the preface to their book on "Electrical Measuring Instruments," the authors state that "some apology would seem to be necessary for issuing yet another book on electrical instruments." It is true that a certain number of books of varying merit have appeared within the last few years, but the authors need be under no apprehension as to the need for the book which they have just published.

A book on electrical measuring instruments such as that which has been produced by Messrs. Drysdale and Jolley is of permanent value. It contains a fund of information about their design, the materials used in their manufacture, and the precautions that should be taken to secure accuracy, which will render it of very great value to instrument makers and electrical engineers. If one tests the book by looking for information on the less-known instruments, one seldom fails to find it. The only serious criticism which may be offered is the comparatively meagre information given about the qualities of cobalt steel. This material is being used in increasing quantities in Great Britain, and a large amount of research work on it has been carried out within the last few years.

The volume opens with a short account of the general principles involved in the measurement of electrical currents. The second chapter deals with mechanical design, and the various types of ammeter, voltmeter, and wattmeter are classified in accordance with their methods of control. Much useful information is given on such subjects as the properties of cylindrical springs and the arrangement of damping vanes. There is an interesting note on pivots and on the methods of manufacturing them to ensure good wear. In this and the following chapters such matters as the mounting of the series resistances of voltmeters, the design of reactances for minimum power factor, the construction of condensers with zero temperature coefficient, the methods of constructing pointers and scales, and of leading in the conducting wires to instruments, are discussed with great care and thoroughness. It is the study of points like these that makes the difference between a good instrument and a bad one. Chap. iii. deals with the quickness of action of instruments, and the considerations in the design that are important from this point of view; fundamental electrostatic and magnetic theory is discussed, and among other matters the legal definitions of the units of current voltage and resistance are included, and also some elaborate tables of the working constant of instruments made by different manufacturers.

One of the most useful parts of the book is Chap. v., which deals with the properties of electrical materials. After a general account of the ordinary materials used as conductors, and those employed for insulating wires, some figures are given for the most suitable current densities to use in ammeter coils, and for the resistance per volt in voltmeters. The thermo-electric properties of alloys are discussed in detail, and the properties of the material known as "Therlo," which has been produced in the United States as a substitute for manganin, are included. Some interesting data are given of the dielectric strength and insulation resistance of dielectrics. Evershed's well-known work on the effect of moisture on insulation is dealt with, as well as the less-known work of Thornton on dielectric constants. No account of insulating materials nowadays is complete which does not give some data relating to bakelite and its derivatives, and a good deal of information is to be found about it, as well as about bitumen and impregnating materials. In dealing with magnetic substances, some useful data are given of the Heusler alloy, including its hysteresis loss for a good range of flux density. Yensen's vacuum iron is mentioned, and figures relating to it are given. The remaining chapters of the book deal with the properties of the principal types of instrument, namely, moving coils instruments, soft iron instruments, dynamometer types of voltmeters, ammeters, and wattmeters, hot-wire instruments, and electrostatic instruments.

The figures and tables that are included in these chapters must have involved careful and elaborate research, both in obtaining the necessary data and in classifying them. They provide a very valuable

compendium of information about present-day instruments.

This book should be on the shelves of all electrical engineers and instrument makers.

(2) Dr. Kennelly's work on telephone receivers and other vibrational instruments is well known, and his method of considering the characteristics of telephone receivers as reciprocating electric motors has been widely recognised. He says in the preface, "The basic idea in the subject-matter is that every electrical vibration instrument possesses a motional impedance diagram, which is its fundamental form and is capable of disclosing many electro-mechanical characteristics of the instrument."

The book starts with an account of the Bell telephone receiver, and describes the various types which are now being manufactured. A considerable part of the subject-matter in the following chapters describes the researches Dr. Kennelly and his assistants have made on the vibration of the telephone diaphragm, and the collection of these papers into a book will be of great value to those who are interested in this subject. Nowadays, when the clear reproduction of speech and music is occupying the attention of so many people interested in broadcasting, the book should be of especial interest. Not only does Dr. Kennelly deal very thoroughly and completely with the telephone receiver, but his book also contains a very good account of the various forms of vibration galvanometer which are now in use in light-current laboratories, as well as many of the different forms of oscillograph. In this connexion the oscillographmeter which Dr. Kennelly has devised is described. All those who are interested in light-current electrical measurements and the development of the telephone will find that this book is a necessary addition to their libraries.

Mendelian Studies.

Studia Mendeliana: ad centesimum diem natalem Gregorii Mendelii a grata patria celebrandum. Adiuvante ministerio Pragensi edita. Pp. 415. (Apud "Typos," Brunae, 1923.) 50 Kč.; 1½ dollars.

THE centenary of the birth of Gregor Mendel was celebrated at Brunn in 1923 by an international meeting of biologists. In "Studia Mendeliana" are collected twenty-four papers written in honour of the occasion. The inclusion in this volume of several papers on general evolution, of others on cytology, anthropology, the evolution and inheritance of sex, and lastly on the transplantation of tissue in relation to specific difference, illustrates the variety of the modern developments which have grown out of Mendel's fundamental discovery.

Among the papers on evolution is one by Prof. Lotsy on the importance of hybridisation in the production of new forms both in Nature and among domesticated races. Prof. V. Haecker writes on the origin and classification of racial characters, and advocates a close analysis of their occurrence in related forms from an evolutionary point of view. Prof. Witschi discusses the theory of orthogenesis, specially in relation to the evolution of sex. He regards sex differentiation as forming an orthogenetic series, culminating in forms with complete sex differentiation and determination at the reduction division. But the coincidence between sex determination and the reduction division is unessential, as shown by haploid and diploid hermaphrodites in animals and plants. From Witschi's own experimental work on rudimentary hermaphroditism and sex inheritance in local races of Rana, he concludes that they represent stages in the passage from the hermaphroditism of the Chordata to the highest forms of sex differentiation and determination at the reduction division. Differences between the local races of Rana he attributes to quantitative changes in the sex genes, brought about by indirect action of external conditions—an interpretation closely akin to that of Goldschmidt in his work on inter-sexes in Lymantria.

Working on Drosophila, Prof. Mohr has found a new case of the interesting phenomenon named by Bridges "deficiency," this term indicating the loss or inactivation of a section of a chromosome involving several genes. Hitherto such cases have been found only in sex-linked characters, but here the second chromosome is affected. Mohr makes the suggestion that all the dominant mutations in Drosophila which are known to be lethal when homozygous may turn out to be due to "deficiency." A report on the progress in the cytological and genetical investigation of the genus Crepis is made by Babcock, Collins and Mann. It is remarkable that the cross between *C. setosa* with four pairs, and *C. biennis* with twenty pairs of chromosomes, has given a hybrid with twenty-four pairs of chromosomes, and this hybrid has proved to have some degree of fertility. The authors regard this as an indication that more than one pair of homologues exist in the *C. biennis* group.

Dr. W. E. de Mol writes on heteroploidy and cross-fertility in *Hyacinthus orientalis*. He found both diploid and heteroploid forms to be self-sterile, but cross-fertilisations in general gave good seed. Heteroploid forms frequently arise as bud sports on diploids, and it is of special interest that these will not cross with the forms from which they derive.

In her essay on the transplantation of living tissue, Frl. Erdmann discusses the work of Leo Loeb on the

"individual differential" in newly-born rats and guinea-pigs of known breeding. Loeb found that the closer the relationship the more successful were the transplantations. The slightest difference in relationship affected the results, even brother to brother transplantations being more successful than those from parents to children. From the work of Spemann it is known that such individual distinctions arise during the development of the embryo, and Erdmann and others have suggested a parallelism with interspecific fertility. Nevertheless, Loeb has shown that in *Rana temporaria* these distinctions are independent of, or subsidiary to, the specific differential. Of great interest is Erdmann's observation that interspecific transplantations in Rana are facilitated by an intermediate period of growth of the graft in various media. C. P.

Oceanography.

An Introduction to Oceanography: with Special Reference to Geography and Geophysics. By Prof. James Johnstone. Pp. xii+351. (Liverpool: University Press of Liverpool, Ltd.; London: Hodder and Stoughton, Ltd., 1923.) 15*s.* net.

OCEANOGRAPHY is an extraordinarily composite subject; it touches on almost every branch of science, from the astronomical theory of the tides to the biological significance of the plankton. For this reason it is difficult for the student to weld the very varied facts at his disposal into a single consistent body of knowledge. Herein lies the value of a book such as this, which brings out the general theory in a clear and very readable manner without unnecessary detail.

After a brief description of its morphology, the probable origin of the world-ocean is discussed. This leads naturally to the consideration of its depth and the character of the bottom and the nature of the ocean margins. Great stress is rightly laid on the very small vertical scale of the surface features of the earth. Two chapters then follow on the chemistry and physics of sea-water. In the chapter on the tides, the author has attempted with very fair success the difficult feat of a non-mathematical exposition of the theory of their production. The oceanic circulation is described and explained very clearly, so that the significance of the underlying causes can be fully appreciated. The final chapter on secular changes in the ocean is perhaps the most interesting and suggestive, and fixes in the mind the ideas put forward in the rest of the book.

When so wide a field is covered it is almost impossible for the standard to be maintained throughout. The chapters on the chemistry and physics of sea-water are not quite so good as the rest of the book. In the section on the hydrogen ion concentration of sea-water, the notation has been confused, the symbol pH being used at first (p. 149), where it is obvious that the hydrogen ion concentration, C_H, is referred to, although later "pH" is correctly defined and expressed (p. 153). In the description of the effect of cooling a solution of sodium chloride (p. 185) it is incorrect to say that "The quantity of ice formed increases, the quantity of sodium chloride crystals formed also increases and the concentration of the solution remaining unfrozen increases." As the eutectic is approached, *either* pure ice or pure sodium chloride crystals separate according to the initial concentration of the salt. Not until the eutectic is reached do salt crystals and ice separate out together (*vide* "A System of Physical Chemistry," vol. ii., W. C. McC. Lewis, pp. 247 and 248).

The explanation on page 186 of why ice formed from sea-water floats is strange. The expansion of water on solidification has been overlooked. The ice formed from sea-water is not only lighter than sea-water but is lighter than fresh water, since its specific gravity is about 0·92 (*vide* "Handbuch der Ozeanographie," Band I., Dr. O. Krummel, p. 507).

Apart from these sections the book is excellent, and it is hoped that they will be revised in the next edition. The illustrations are well done, and there is a good appendix which can be referred to for literature. There are few misprints; the formula at the top of p. 147 should read "$Q=P.K/T$," and on p. 191, line 18, "more" should read "less," while on p. 187 "$NaSO_4$" should read "Na_2SO_4."

Our Bookshelf.

(1) *Outlines of Fungi and Plant Diseases: for Students and Practitioners of Agriculture and Horticulture.* By F. T. Bennett. Pp. xi+254. (London: Macmillan and Co., Ltd., 1924.) 7*s.* 6*d.* net.

(2) *Practical Botany.* By Rai Bahadur K. Rangachari. Pp. iii+114. (Madras: Government Press, 1923.) 18 rupees.

(3) *British Mosses and How to Identify Them.* By J. H. Crabtree. (How to Identify Series, No. 19.) Pp. 63. (London: The Epworth Press, 1924.) 1*s.* 6*d.* net.

(4) *Plant Studies.* By Prof. James A. Todd. (Foundations of Nature Study Series.) Pp. 151. (Edinburgh: A. Baxendine and Sons, 1924.) 2*s.* 6*d.* net.

(5) *The Nature-World of London.* By Walter Johnson. 1: Trees and Plants. Pp. viii + 118 + 8 plates. (London: The Sheldon Press; New York and Toronto: The Macmillan Co., 1924.) 3*s.* net.

(1) MR. BENNETT'S book on fungi and plant diseases has been written more particularly for students of agriculture and horticulture. It should serve its purpose very well. The first part gives a general account of the fungi, with a short classification and the life histories of a number of members of the various groups. The second part deals with plant diseases as

such. The modern study of this subject only began about 1866, but has developed in many aspects in recent years. The chapter dealing with the general aspects of parasitism, such as infection, resistance, and immunity, might very well have been considerably extended. In later pages all the better known fungus diseases of crops, from mycetozoa to rusts and bacteria, are clearly described, together with their effects on the host plant and methods of treatment. In connexion with wheat rust, the important developments since the "bridging" theory was generally held are only referred to in a footnote. The volume will be useful to all those who wish to acquire a general knowledge of plant diseases. Its conciseness and arrangement will appeal to the student.

(2) The second work on our list is a small book of laboratory exercises to accompany the author's "Manual of Elementary Botany for India." The plants studied and illustrated are chiefly tropical forms such as *Dolichos lablab*, *Arachis hypogæa*, and *Andropogon sorghum*, which are not generally examined in European laboratories. The figures, many of which are photomicrographs, would have been clearer in some cases if they had been taken with a higher magnification. The book is in three sections, the first dealing with the morphology of root, stem, leaf, flower, and fruit; the second with physiology, in which various simple experiments are outlined; and the third with Cryptogams.

(3) The author gives in small space popular descriptions of about sixty of the commoner British mosses. On each page two species are described, with photographs of the species on the accompanying page. Technical terms are avoided, but habitats, and in some cases localities, are given. This popular treatment should enable moss-lovers to recognise genera, and in many cases species, without much difficulty. The photographs usually show the habit without attempting to portray any further detail.

(4) Mr. Todd's book is one of a series on the foundations of nature study. It is intended for teachers who are conducting school classes in this subject. Beginning with a short chapter on the cellular structure of plants, there follow others equally brief on the various plant organs, vegetative reproduction, plant identification, trees and cryptogams, with a final chapter of notes on ecology. The definition of a flower (p. 53) is not very happy, and some of the figures suffer from their small size. Those who have had no previous acquaintance with botany would find it of greatest use.

(5) The charmingly written little book of Mr. Walter Johnson is full of lore concerning the trees and other plants of the London area, as they are known to the author. Botanist and layman alike can find entertainment in its pages. The historical trees referred to include Nelson's mulberry and Captain Cook's "cotton tree," which is a balsam poplar. Chapters on the wild flowers and weeds of London are equally entertaining accounts of plants found in the commons, gardens, and open spaces of London. In the final chapter on London's mushrooms and toadstools, many of the common forms are mentioned, including some of those found in wine cellars. It is to be hoped that the author's promise of a further volume on other phases of Nature in London will be carried into effect.

Kitāb al-'ilm al-muktasab fī zira'at adh-dhahab: Book of Knowledge acquired concerning the Cultivation of Gold. By Abu'l-Qāsim Muḥammad ibn Aḥmad al-'Irāqī. The Arabic text edited with a translation and introduction by E. J. Holmyard. Pp. iv+62 +53. (Paris: Paul Geuthner, 1923.) n.p.

MR. HOLMYARD in the introduction to his book remarks justly that "the investigation of the original sources of Arabic chemistry has scarcely yet been attempted." The most important work was that of Berthelot, yet owing to the limited range of works studied, particularly in the case of Jabir ibn Hayyān, it is likely that some of the conclusions of the great French historian of chemistry may require modification. A reaction against the rather premature generalisations of Berthelot, which are most warmly supported by those who have no knowledge of the original sources, has undoubtedly set in, and the further investigation of Arabic sources by those competent to undertake the work will no doubt provide information of great interest to students of the history of chemistry.

The text published by Mr. Holmyard is a small treatise by a thirteenth-century Arabic alchemist. The intrinsic interest of the work is not very great: the theory that all metals are really the same and differ only in unessential properties, which may be removed, is Aristotelian, but the assumption that "the metallic substance freed of such accidental properties is gold" seems unusual, and, as Mr. Holmyard says in his introduction, was opposed by other Arab chemists, including Ibn Sina ("Avicenna"), who held that each metal is distinct. The author speaks of the "two leads," the "two coppers," and so on; some materials will "turn copper yellow with the yellowness of gold," but "do not make it complete." As the Latin Geber says, *tutia* will "citrinise copper of a good yellowness," but he adds that it is to be taken only for "the lesser work," *i.e.* for deception only. The comparison of the elixir, which is to transmute metals, with the remedy, which is to cure disease, is instituted. Many names of Greek-Egyptian alchemists, such as Zosimus, Agathodemon, Maria, etc., are mentioned: the first as "the Jew"; Khalid ibn Yazid and Marianus also appear. The "Art of the Egyptians" is chemistry. All this points clearly to the sources: Arabic chemistry came from Hellenistic Egypt in the first instance, and one of the important questions to which further research will disclose an answer is how much original work the formerly much vaunted Arabic alchemists really did.

Mr. Holmyard must be congratulated on his book, and readers will look forward to the conclusions he will perhaps draw from the study which has enabled him to produce it. Of the Arabic text the reviewer is unable to offer an opinion, but it has been looked through by Prof. Browne and Mr. Steele, who are experts.

J. R. P.

L'Hérédité. Par Prof. Émile Guyénot. (Encyclopédie scientifique: Bibliothèque de Biologie générale.) Pp. 463. (Paris: Gaston Doin, 1924.) 19·80 frs.

THE scientific experimental study of heredity may be said to have begun with the present century. The views of the early hybridisers were too vague, and were based upon results too varied and indefinite to lead anywhere. Moreover, the work of the nineteenth

century was required to build up an edifice of knowledge concerning organic structure and development, the nature of sexual reproduction, and the structural basis of heredity, before definite views of the laws of inheritance could be propounded and accepted. But in the last twenty-four years advance has been rapid, because all these and other lines have converged upon the solution of the central problem of heredity. Where all was formerly hazy and nebulous, results are now seen to be clean-cut and precise, continually opening up further vistas of understanding concerning the relations between the details of organic structure as we find them, and the laws and exceptions to the laws of inheritance as they are developed by experimental work.

While the advances in Mendelian heredity, sex chromosomes, etc., have been rapidly incorporated into biology on account of their fundamental character, yet to the lay mind heredity remains for the most part an unintelligible and almost mystical "force." Even the medical profession remains in an uninstructed condition regarding a subject which vitally concerns their daily activities.

Any book which spreads the modern knowledge of heredity is therefore to be welcomed, and the volume before us, by Prof. Guyénot, should be very useful in this respect for French-speaking peoples. The author's definition of heredity is worth quoting: "L'hérédité consiste dans la totalité des réalisations morphologiques ou physiologiques que le descendant tient de ses parents."

The volume is divided into three sections. The introduction begins with a chapter on the continuity of living matter as the basis of heredity. The sections deal with the laws of hybridisation, the chromosome theory of heredity, and Mendelian anomalies. In the last, such topics as hyperdactyly in fowls, lethal factors, cytoplasmic inheritance, and xenia are discussed. The final chapter is devoted to inheritance in man. While containing little or nothing that is new to the geneticist, the book presents a useful summary of recent advances in this field. The number of Drosophila mutations has now reached more than 300, not 100 as the author states.

R. R. G.

Human Protozoology. By Prof. Robert W. Hegner and Prof. William H. Taliaferro. Pp. xix+597. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1924.) 4.50 dollars.

THIS work has been prepared primarily for the use of students in the authors' course of protozoology in the School of Hygiene of the Johns Hopkins University, but it will be of great use to students pursuing similar courses in other institutions, and to medical officers who desire a concise statement of the facts of protozoology. Emphasis is rightly laid on the value of a study of parasites from lower animals, which are often more easily obtained than the allied species occurring in man, and serve as excellent material for practice in technique and in the study of life-cycles.

In the general introduction to the organisation of the protozoa, structure and modes of division are considered. The following chapters deal in turn with the main groups of protozoa, the structure and life-history of representative genera and species being described and careful reference made to the methods of spread of those which occur in man. A chapter is devoted to the genetics and the physiology of reproduction in the protozoa, and a final chapter gives useful information on the diagnosis of intestinal protozoa. A well-chosen list of books and memoirs on protozoa occupies some fifty pages, there is an adequate index of authors and of subjects, and the volume is excellently illustrated by clearly drawn figures.

In reviewing a work which is so well done it is almost ungracious to ask for more, but here and there the authors might consider whether in their next edition they could add a few further details; *e.g.* in the chapter on Hæmosporidia (exclusive of malaria) it would be useful to have some account of the life-history of Piroplasma, incompletely known though it be, and of *Theileria parva*, a short account of Proteosoma, and a reference to Mrs. Adie's work on Hæmoproteus.

The authors are to be congratulated on the production of this excellent manual.

A Check-List of British Birds: With a Short Account of the Status of Each. Compiled from "A Practical Handbook of British Birds." By H. F. Witherby. Pp. 78. (London: H. F. and G. Witherby, 1924.) 3*s.* 6*d.* net.

ORNITHOLOGISTS will welcome this little book, which is printed on one side only of the paper for convenience in labelling or for the making of notes. The fact that it is taken from the "Practical Handbook of British Birds" is a sufficient guarantee that it is up-to-date and correct in all matters ornithological and nomenclatorial.

From the biological point of view, it is very instructive to look down the pages of the book and note which of the species remain binomial, which have run into trinomials. The latter, of course, are in the great majority—a sign of the enormous amount of geographical variation which patient research reveals. The problem is to understand why some species show this tendency to break up into geographical races or subspecies, while others remain invariant. The lack of variability in some of these may be apparent only, due to our ignorance; but this cannot be true of the Chough, the Snow-Bunting, the Brambling (the specific name of which, by the way, contains a misprint), the Meadow-Pipit, the Waxwing, the Lapwing, the Redwing, and many others. Sometimes whole groups, such as the Tits or the Wheatears, seem to show excessive variability, while the Anseres contain an unusually large proportion of "unsplit" species.

The evolutionary biologist should pay more attention to the rich mine which the labours of the systematist, most notably in the group of birds, have opened up for him.

J. S. H.

Exercises on Ordnance Maps. Selected and arranged by C. H. Cox. Pp. 60+12 maps. (London: G. Bell and Sons, Ltd., 1924.) 1*s.* 9*d.*

ELEMENTARY and advanced exercises are based on twelve sections of different scale ordnance maps of various styles. Concentration on map work of this nature is the best introduction to the study of geography. Even if some of the questions are a little far-fetched as exercises on the maps, the book is excellent and deserves to be widely used in schools.

R. N. R. B.

Letters to the Editor.

The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.*]

On the Vibrations of Air in Organ-Pipes of Unusual Shapes.

IN 1867–68, when I was Principal of La Martinière College, Calcutta, I made some experiments on organ-pipes in conjunction with the Cathedral organist, Mr. Frye, who was trying to rebuild a small organ on which to practise in his own room. His problem was how to get pedal-tones from pipes smaller than the regulation minimum, namely, 8 ft. stopped diapason, a very inconvenient size in an ordinary house. I studied his "Hopkins and Rimbault," and became quite fascinated with the subject, chiefly on its scientific and mathematical side.

Mr. Frye supplied the first hint for a solution of the problem. He noticed how low were the tones given by a large bottle with a small neck, when blown across the mouth like a flute. For example, a bottle which stands easily in a space 1 ft. high on a base $4\frac{3}{4}$ in. in diameter gives the note Bass E♭, the pitch of an open diapason pipe about 6 ft. 8 in. from mouth to top. But the practical difficulties in the way of making a pedal "bottle-stop" proved too much for him.

I found my available text-books useless, and had to invent the mathematical investigation for myself. A "bottle-pipe" is really two pipes of unequal diameters, joined together by a flange from the outer edge of the smaller pipe with the mouth-piece, to the inner edge of the larger stopped pipe. The text-books give the formulæ of vibration in a uniform cylinder, either open or stopped. I took these formulæ for the two separate parts, and made them fit at the junction by the two conditions, that the air-pressures must be the same for both, and that with each swing the volume of air thrown from the small part into the large must be equal to the volume returned by the large into the small. Hence I deduced the formula

$$\tan mh \,.\, \tan mk = \frac{\text{area of mouth-part}}{\text{area of stopped part}} = \frac{r^2}{R^2},$$

where h and k are the lengths of the two parts, r and R their radii, and m is proportional to the vibration-rate of this composite pipe, so that $ml = \pi$, if l be the length of the open diapason of the same pitch.

This formula shows that h and k are interchangeable, so that the mouth-part may be short and the stopped part long, or the reverse, without altering the pitch. It is also easy to see that the lowest note will be obtained by making the two parts of the same length. This form gives us a new kind of organ-pipe which I call a *Bicylindron*. If r be the radius of the mouth-part, and R that of the stopped part, and h the length of either half, then

$$\tan^2 mh = \frac{r^2}{R^2} \text{ or } \tan mh = \pm\frac{r}{R},$$

where as before $ml = \pi$ gives the length l of the "tone," as estimated by organists; *i.e.* Bass C = 8 ft. tone; Tenor C = 4 ft. tone, etc.

That the above formulæ are accurate enough for practice I have proved by making zinc models with suitable measurements.

It can easily be seen from this formula that a *Bicylindron* "stop" can be made of two varieties. If $r < R$ the pitch will be lower than that of a stopped diapason of the same total length, $2h$. If $r > R$ the pitch will be higher; but it will be lower than that of an open diapason of length $2h$. For a pedal-stop, of course, r must be less than R.

But "Hopkins and Rimbault" gave another solution. There is an organ in Oxford, with a *Pyramidon* stop, invented by Ouseley. Each pipe is an inverted pyramid, closed at the base, with a mouthpiece at the narrow end, near the apex. The writer is astonished at the low note such pipes give in comparison with their height; but he attempts no explanation of the mystery. To the mathematician such a pipe is merely a conical pipe, closed at the broad end. My copy of Besant's "Hydrodynamics," said not a word about conical pipes, though almost all reed-pipes in an organ have open conical resonators. So I had to invent the theory for myself, and found out the formula, which gives the fundamental note and the overtones, namely,

$$\tan mh = mk,$$

where h is the distance from mouth to base, and k from vertex to base, m having the same meaning as before. I verified this formula by a few small zinc models. It is not given in Basset's "Elementary Hydrodynamics" (1890), nor in Lord Rayleigh's "Theory of Sound" (1894). The latter works out the theory of open conical pipes, and shows that they are, in pitch and in harmonics, equivalent to cylinders, as organ-builders know by experience. Basset perversely limits himself to conical pipes *without any mouthpiece*; so that his investigation is useless for the *Pyramidon*. But I have worked out the problem from the data given by both authors, and deduced from either the formula given above. Both authors give the formula for the mouthless pipe, namely,

$$\tan mk = mk,$$

which is merely a particular case of my formula, when $h = k$; *i.e.* when the mouthpiece is run down to a mere point at the vertex.

From the formulæ given above, mathematical readers can prove that, space for space, a *Bicylindron* always beats a *Pyramidon* for depth of pitch. For example, if the breadth at the stopped end be 9 inches for both, and the breadth at the mouth 3 in., and the height from mouth to stopper be 2 ft., the *Pyramidon* gives nearly a $6\frac{1}{2}$ ft. tone, while the *Bicylindron* gives a tone rather lower than $9\frac{2}{3}$ ft.

But the all-important consideration has not yet been noticed. In an organ everything depends upon "quality of tone"; and it is now an established axiom that quality of tone depends upon the proportionate admixture of harmonic overtones. The standard musical instruments—violin, piano, and organ—all give the complete series of natural musical harmonics, the vibration-rates of which are proportional to the series

1, 2, 3, 4, 5, etc., *ad infinitum*.

There is one exception in the organ. The stopped diapason can give only the odd harmonics, 1, 3, 5, 7, etc. The octave harmonics, which make the tone bright and clear, are all cut out. Thus a stopped diapason can give a soft sweet tone, but can never give the full rounded ring of the open diapason. Its chief advantage is that it takes up only half the space and saves half the cost in materials.

Now the formulæ given above prove that the overtones of a *Pyramidon* are all incommensurable and therefore unmusical. The best voicer in the world can make nothing out of it beyond a dull humming note. But with the *Bicylindron* all we have

to do is to make the ratio $\nu : R$ exactly equal to $\tan \pi/n$, where n is any integer, and we shall get the harmonic sequence

$$1, n-1, n+1, 2n-1, 2n+1, 3n-1, 3n+1, \text{ etc.}$$

For pedal notes the best values of n are 5, 7, or 9; these will give octave harmonics. If we take $n=5$ we shall get a pipe shorter than the stopped diapason of the same pitch in the ratio of 4 : 5; but its harmonic overtones will be the series

$$1, 4, 6, 9, 11, 14, 16, \text{ etc.},$$

which should give a far better quality than the ordinary stopped diapason.

But the best of all for quality is the $\pi/3$ *Bicylindron*, the length of which is two-thirds that of the open diapason of the same pitch. This pipe has the harmonic sequence

$$1, 2, 4, 5, 7, 8, 10, 11, 13, 14, 16, \text{ etc.}$$

This pipe, if properly voiced, should make a solo stop with a unique loveliness of tone. Experimentally I have proved the sequence 1, 2, 4, and 5.

I worked out my formulæ in the case of a double conical pipe, made of two cones joined together at the broader equal ends, each tapering to a smaller mouth in opposite directions. The result can be found by a very pretty calculation from the formulæ given by Basset or Lord Rayleigh; it is

$$m \sin m\mathrm{H} = \left(\frac{1}{k} + \frac{1}{k'}\right) \sin mh \sin mh',$$

where $\mathrm{H} = h + h'$; h and k have the meaning given above for the *Pyramidon*; h' and k' the corresponding quantities for the second cone; and m gives as before the vibration-rate of the whole pipe, which is of lower pitch than an open cone of the same length. This double pipe is intended for reed-stops, which need a cone tapering to the narrow reed-tube. By taking $h' = h$ or $h/2$ we can get all the harmonics of the open cone h'; and by giving suitable values to k and k' we can ensure that the fundamental tone shall be an exact double octave below the open cone h', thus gaining the conditions for good quality. Hence we find in either case

$$\frac{1}{k} + \frac{1}{k'} = \frac{\pi}{2h}.$$

In 1868 I made four pipes on this plan, using some harmonium reeds I had by me, of pitch Tenor C, D, E, and F. Mr. Frye tried them in the Cathedral organ. We both agreed that the tone was very beautiful, when it came on. But there was a distinct burr at the beginning and end of the tone, and the pipes were so "slow of speech" that in a quick run they never spoke at all. Such "free reeds" are probably inappropriate: they are never used by English organ-builders. But the experiment shows that in expert hands a reed-pipe of this kind might be made with a tone of unique beauty, free from all defects of "speech." JAMES A. ALDIS.

The Quantum Theory of Dispersion.

IN a recent letter to NATURE (May 10, p. 673) Dr. Kramers advanced a quantum theory of dispersion which is a generalisation of the theory of Ladenburg. The formula proposed by Kramers for the polarisation of an atom when put in a wave is his formula (5). This formula is stated by Kramers to satisfy the condition demanded by the Correspondence Principle, namely, that the dispersion due to an atom in a state of high quantum number is the same on the classical and on the quantum theories [1] The presence of the second term has been introduced by Kramers for this purpose. From the point of view of the virtual oscillators of Bohr, Kramers, and Slater, the second negative term of Kramers is somewhat dissatisfying, because an oscillator would give rise only to a term of the first positive type

The present writer has been also considering the question of interaction between radiation and quantised atoms in connexion with the question of the Brownian movement of atoms in black body radiation. A picture similar to the virtual oscillator finds application also in that field. However, the exact form of the interaction has been conjectured by the writer to be somewhat different from that proposed by Kramers.

The difference can be illustrated in the case of the linear oscillator. In this case the expression of Kramers becomes at long wave-lengths

$$P = [n - (n-1)]\frac{e^2}{m}\frac{1}{4\pi^2(\nu_i^2 - \nu^2)} = \frac{e^2}{m}\frac{1}{4\pi^2(\nu_i^2 - \nu^2)}.$$

The same result may be also derived as

$$P = [\tfrac{1}{2} + \tfrac{1}{2}]\frac{e^2}{m}\frac{1}{4\pi^2(\nu_i^2 - \nu^2)}.$$

In this manner the negative term may be avoided. In order to satisfy the Principle of Correspondence, the dependence of P on ν must be in general slightly more complicated than that for the oscillator. This dependence can be derived from a consideration of a "virtual orbit" rather than a virtual oscillator. (I am indebted to Prof. Van Vleck for this term.) The "virtual orbit" has the same frequency as the "virtual oscillator." However, its reaction to the external field is comparable with that of an electron, the orbit of which is the mean of all the orbits between the two stationary states. (The meaning of "mean" is of necessity somewhat indefinite.) It is clear that in the general case a properly taken sum of the contributions of the various ν_i^a, ν_i^e will give the required result. Thus it is sufficient to attribute to a transition between a quantum state of quantum number $(n_1 + \tau_1, \ldots n_u + \tau_u)$ to $(n_1, \ldots n_u)$ one half of the contribution to the polarisation on the classical theory due to the terms in frequencies $\tau_1 w_1 + \ldots + \tau_u w_u$ (in Bohr's notation) in order to satisfy the Principle of Correspondence.

It appears that the form of the theory here outlined is better capable of explaining dispersion at long wave-lengths (say for an atom in the normal state) than the form of Kramers because the characteristics of the motion are of greater influence on the "virtual orbit" than on the "virtual oscillator" point of view. By introducing a properly taken mean, one may hope to obtain the influence of a static field as a limiting case of a field considered in the theory of dispersion. G. BREIT.

Physics Department,
The University of Minnesota,
Minneapolis, Minn.

[1] Prof. J. H. Van Vleck, of this University, has shown, in a publication which is to appear soon, that this formula satisfies the Correspondence Principle for the case of the general non-degenerate multiple periodic orbit.

THROUGH the courtesy of the Editor of NATURE, I have been permitted to see Mr. Breit's letter, and I welcome the opportunity thus afforded me to add some further remarks on the theory of dispersion, in order to elucidate some points which were only briefly touched upon in my former letter.

In addition to the empirical applicability of a dispersion formula of the type (4), the arguments which

led to the proposal of formula (5) rested on the classical expression for the amplitude of the secondary wavelets which an incident plane wave sets up in a system of electrified particles. Consider a system, the motion of which is of multiple periodic type, and let the electrical moment M in a given direction of the undisturbed system, which is supposed to possess u independent fundamental frequencies $\omega_1, \ldots \omega_u$, be represented by

$$M = \Sigma C \cos(2\pi\omega t + \gamma), \quad . \quad . \quad . \quad (1^*)$$

where the frequencies $\omega = \tau_1\omega_1 + \ldots \tau_u\omega_u$ and the amplitudes C depend on the quantities $I_1, \ldots I_u$, which in the theory of stationary states are equal to integer multiples of Planck's constant h, as well as on the set of integer τ-values characteristic for the considered harmonical component of the motion. Let next the incident wave be linearly polarised with its electrical vector parallel to the given direction, and let the value of this vector at the point where the system is situated be given by $E \cos 2\pi\nu t$. The electrical moment of the forced vibrations of frequency ν set up in the system will then be equal to

$$P = \frac{E}{2}\Sigma\frac{\partial}{\partial I}\left(\frac{C^2\omega}{\omega^2 - \nu^2}\right) \cos 2\pi\nu t, \quad . \quad . \quad . \quad (2^*)$$

where $\frac{\partial}{\partial I}$ stands as an abbreviation for $\tau_1\frac{\partial}{\partial I_1} + \ldots \tau_u\frac{\partial}{\partial I_u}$.

Now in the limit of high quantum numbers the frequencies of the spectral lines connected with the different possible transitions will coincide asymptotically with the frequencies of the harmonic components of the motion, and, according to the Correspondence Principle, the energy of the spontaneous radiation per unit time combined with each of these frequencies will be asymptotically represented by the expression $\frac{(2\pi\omega)^4C^2}{3c^3}$. We will now make the assumption that, in this limit, formula (2*) gives an asymptotical expression for the dispersion. In order to obtain a general expression holding for all quantum numbers we note that, while the frequencies ω of the harmonic components of the motion are given by the general formula

$$\omega = \frac{\partial H}{\partial I},$$

the exact expression for the frequencies of the spectral lines is given by the general quantum relation

$$\nu_q = \frac{\Delta H}{h},$$

where ΔH signifies the difference of the energy H in two stationary states for which the values of $I_1, \ldots I_u$ differ by $\tau_1 h, \ldots \tau_u h$ respectively. The assumption presents itself that, in a generalisation of formula (2*), the symbol $\frac{\partial}{\partial I}$ has to be replaced by a similar difference symbol divided by h. This is just what has been done in establishing formula (5). In fact, this formula is obtained from (2*) by replacing the differential coefficient multiplied by h, by the difference between the quantities $\frac{3c^3A^a h}{(2\pi)^4\nu^{a2}(\nu^{a2} - \nu^2)}$ and $\frac{3c^3A^e h}{(2\pi)^4\nu^{e2}(\nu^{e2} - \nu^2)}$ referring to the two transitions coupled respectively with the absorption and emission of the spectral line which corresponds with the harmonic component under consideration.

Apart from the problem of the validity of the underlying theoretical assumptions and of any eventual restriction in the physical applicability of formula (5), the dispersion formula thus obtained possesses the advantage over a formula such as is proposed by Mr. Breit in that it contains only such quantities as allow of a direct physical interpretation on the basis of the fundamental postulates of the quantum theory of spectra and atomic constitution, and exhibits no further reminiscence of the mathematical theory of multiple periodic systems.

In this connexion it may be emphasised that the notation "virtual oscillators" used in my former letter does not mean the introduction of any additional hypothetical mechanism, but is meant only as a terminology suitable to characterise certain main features of the connexion between the description of optical phenomena and the theoretical interpretation of spectra. This point is especially illustrated by the appearance of negative as well as positive oscillators, which helps to bring out the new feature, characteristic of the quantum theory of spectra, that the emission and absorption of a spectral line is coupled with two separated types of physical processes. The fundamental importance of this general feature for the interpretation of optical phenomena is, as mentioned in my former letter, indicated by the necessity, pointed out by Einstein, of introducing the idea of negative absorption in order to account for the law of temperature radiation.

H. A. KRAMERS.

Institute for Theoretical Physics,
Copenhagen, July 22.

Lake Victoria and the Flow of the Yala River.

DURING a recent investigation into the epidemiology of sleeping sickness along the east coast of Lake Victoria, north of the opening of the Kavirondo gulf, I observed the following phenomena which I trust some readers of NATURE may be able to explain, for I cannot.

The river Yala, which enters the lake at this part of the coast, passes through swamps which are kept back from the lake by sand-banks. Having landed here I noted many channels cut through the sand, running inland from the lake The local natives said, "These were made by our forefathers, six generations ago, to drain the swamps." I pointed out that at that moment (about 9.30 A.M.) the water was not running out *from* the swamp but *into* it from the lake at quite a considerable rate, which I thought might be two miles per hour.

The natives replied that the current ran thus from daybreak until two in the afternoon, when it was reversed and flowed back into the lake. This is the daily routine so long as the lake is at the higher levels of its seasonal variations; when it is low, in the dry season, the flow through these channels is always from the swamp.

I am much puzzled as to the explanation of this diurnal variation, which cannot be accounted for by changes in direction of wind. I was working along that coast for several weeks and soon noted that the breeze from lake to shore (westerly, here) does not commence before 9.30 A.M., often not till ten; until that time, from the small hours, there is a strong cool breeze from off shore.

I omitted to ask the natives in which direction the current flowed during the night: they had said "from daybreak," but that probably means merely the earliest time when they noticed it.

Since it occurred to me that the great loss which must take place from the open lake by evaporation during the heat of the day might conceivably lower

the level of the lake in the afternoon, I obtained readings of the level at Entebbe by the official recorder at 8 A.M., noon, and 4 P.M. On three successive days the records were as follows:

Date.	8 A.M.	Noon.	4 P.M.
July 2	10·42	10·42	10·42
,, 3	10·42	10·42	10·42
,, 4	10·41	10·42	10·41
,, 5	10·40	..	..

This explanation, therefore, is not possible, and indeed seems improbable in consideration of the vast size of the lake and the relatively small amount of water poured into it by the Kagera and smaller rivers, of which the Yala is one. The inflow would need to be very much larger in order to raise the level of the whole lake during a single night.

G. D. HALE CARPENTER,
Uganda Medical Service.

Entebbe, Uganda, July 5.

English Enemies of the American Slipper-limpet, *Crepidula fornicata*.

IN 1923 the present writer found a shell of a dead slipper-limpet (*Crepidula fornicata*) at West Mersea, Essex, bored extensively by the boring sponge *Cliona celata*. This year a good number of living slipper-limpets have been examined, and one, the fourth individual of a chain of 8 living ones, was found with the living sponge boring into the shell. In the shell of the dead animal the sponge could be seen to have bored through all parts including the shelf, but had been inhibited from perforating over almost the whole of the area on the dorsal side, where another slipper-limpet had been attached to it. In the living specimen the sponge can be seen to be forming a honeycomb mesh-work in the dorsal portion of the shell, but it has only perforated to the surface in the postero-dorsal region; the shelf of the shell is also attacked and is almost perforated in places. On the part of the shell where the next individual in the chain was sitting there is a nodular deposition of calcareous matter over strands of the sponge tissue. This deposit has been laid down, not by the owner of the shell, but by the individual sitting on the shell, and undoubtedly as a reaction to the irritation caused by the sponge. Crepidula has, therefore, found an enemy in Cliona in its new environment, and it will be interesting to know to what extent the slipper-limpet will be attacked in future in view of its economic importance.

Crepidula has other enemies. I have observed the whelk-tingle, *Ocinebra* (*Murex*) *erinacea*, attack the shell of Crepidula and bore through to the body, and shells can be found on the oyster-beds also bored either by Murex or Purpura, but it is difficult to estimate whether the boring whelks are of much value in killing off numbers of Crepidula. Whitstable fishermen know that dabs, *Pleuronectes limanda*, eat Crepidula, and I have seen fresh slipper-limpets in recently opened stomachs of this fish, but it seems likely that many of these limpets are obtained from chains broken in the dredging operations. Mr. Luckhurst, of Whitstable, informs me that star-fishes, *Asterias rubens* chiefly, attack Crepidula, especially in winter time, when the slipper-limpets have apparently been weak. Since Crepidula was introduced into England from America round about the year 1880, it will be interesting to know from time to time in the future what English marine animals become inimical to it. At present Crepidula appears to be maintaining its dominance in the rich waters of the Thames Estuary; this year there is a great fall of spat in many places in the north-western portion of the Estuary, although for the last few years the spatfall has been below the average in most places.

J. H. ORTON.

Marine Biological Laboratory,
Plymouth, July 29.

Former Fertility of the Kalahari Desert.

PROF. J. W. GREGORY, in his article on my recent Kalahari pamphlet in NATURE of April 12, p. 539, objected to my citing the Sylphium of Cyrenaica as evidence of the former fertility of the desert. I also gave the wine palm, *Raphia monbuttorum*, as evidence; for, whereas it formerly lived in the Egyptian oases, it is now confined to the more humid regions further south. Hassanein Bey has recently given evidence to the same effect in the oases of Kufra and Ouenat. In the latter place he describes rock drawings of ostriches, giraffes, and other animals that require grassland, and could not possibly live in the desert as it is to-day. The fact that there are no camels shown indicates that the pictures were made before A.D. 640, when the Arabs arrived in Africa with their camels. Nowadays, life in Ouenat would be impossible without these animals.

In South Africa we have the same evidence—Bushman drawings of hippopotamus, rhinoceros, and other animals, where these could not live to-day, although we know they lived all about here 100–150 years ago. The last lion, hippopotamus, and rhinoceros were shot in the neighbourhood by the fathers of people still living in Grahamstown. I have already given the evidence of the Yellow-wood (Podocarpus), the typical Knysna forest tree, still lingering on hills in Namaqualand in what is now practically desert, and a few specimens are found on isolated hills between there and Cape Town. Recently, however, I have been shown by my neighbour, Mr. M. G. Godlonton, a specimen of the Winterberg bamboo (*Arundinaria tessellata*, Monroe), growing in his garden, which is a striking proof of more humid conditions not very long ago. It was only one hundred and fifty years ago since Barrow, Lichtenstein, and le Vaillant saw our Karroo plains swarming with big game, as now in Uganda, and we have every reason to believe that at that time the slopes of the mountains were covered with bamboo forest as now on the Nandi plateau in Central Africa, and of which these few stray stragglers still survive.

The Winterberg is about 7000 ft. and some 50 miles north of Grahamstown. E. H. L. SCHWARZ.

Rhodes University College,
Grahamstown, July 16.

Chalky Boulder Marl at Hastings.

As relief workers in the Hastings district are continuously laying bare geological sections of first-class importance, and as the demands upon my time have precluded the possibility of my bringing the full details before scientific societies, I feel that geologists in general would be interested in a short account of them in the pages of NATURE. They relate not only to Wealden but also to Pliocene and Pleistocene times.

WEALDEN.—Excavations in the Wadhurst clay have brought to light a remarkable richness of both vegetable and animal life; particularly among the mollusca, in which Nature has shown herself most energetic, not only in the cases of well-known genera and species of ordinary character—necessitating a revision of the Wealden mollusca—but in others she has shown great prodigality, some of the gastropods—dextral and sinistral—attaining a length, or height, of sixty feet

and upwards. These sections have also given the life-history of important rocks and rock-structures, and furnished serial examples of the metamorphoses by which the dense hard "blue-stone" is gradually altered into a soft, brilliantly coloured agate-like sandrock. (I have presented a somewhat extensive series of these to the British Museum (Natural History).)

PLIOCENE.—Beds of this age have been cut through, showing deposits of beautiful red-yellow loam, fifty feet thick, now lying at various altitudes, from a little above O.D. up to more than five hundred feet. These overlie a series correllatable with those of Piltdown. The underlying flint gravel is very much panned and of an orange-red colour, so familiar in East Anglia. The basement original sand is now indurated into a sandstone, requiring heavy steel tools to work it, in which were found worked flints. This, I think, is the first time worked flints have been found in a dense tertiary sandstone; naturally, the flints have undergone a great deal of alteration since they were chipped.

PLEISTOCENE.—The latest revelation has been made in the forming of battered-down lawn-tennis courts, upon the adjoining hillsides, and overlying the loam. The most southern court is cut out of chalky boulder marl, very white in colour. The associated boulders were often between two and three feet long, and consist of various gneisses, schists, granites, and numerous volcanic and metamorphic rocks; and sedimentary rocks foreign to the locality; and palæozoic and mesozoic fossils and rocks. The upper part of this big boulder drift was associated with immense worked flints, especially Wealden "flints," bulbed facets sometimes reaching one hundred square inches. The smaller implements are of well-known Mousterian types. In the overlying material came the orange-red-brown implements which I regard as of Aurignacian age. The latter occur by thousands on certain hill-tops and valley shoulders in a quartzite drift full of glacially striated and faceted foreign rocks, originating in the destruction of just such glacial drift as is now revealed. Above these came quantities of the productions of the Hastings Kitchen Midden men. My esteemed colleague, Mr. Lamplugh, informs me that a similar drift has been reported to him from another locality. It now appears certain—if there be such a thing as a certainty—that glacial conditions reached even beyond our present shore line, and probably extended over the Great South river, as is shown by similar deposits near the French coast.

W. J. LEWIS ABBOTT.

Zoological Nomenclature: Thirty-five Generic Names of Mammals.

THE following generic names of mammals (with genotype in parentheses) have been submitted to the International Commission on Zoological Nomenclature for inclusion in the Official List of Generic Names.

The Secretary will delay final announcement of the votes on these names until January 1, 1925, in order to give to any zoologists who may desire the opportunity to express their opinions.

Alces Gray, 1821, 307 (*alces*); *Arvicola* Lac., 1799, 10 (*amphibius*); *Ateles* Geoffr., 1806, 262 (*paniscus*); *Bison* H. Smith, 1827, 373 (*bison*); *Bradypus* Linn., 1758a, 34 (*tridactylus*); *Canis* Linn., 1758a, 38 (*familiaris*); *Capra* Linn., 1758a, 68 (*hircus*); *Cebus* Erxl., 1777, 44 (*capucina*); *Cervus* Linn., 1758a, 66 (*elaphus*); *Cholœpus* Ill., 1811, 108 (*didactylus*); *Condylura* Ill., 1811, 125 (*cristatus*); *Cricetus* Leske, 1779, 168 (*cricetus*); *Crocidura* Wagl., 1832, 275 (*leucodon*); *Cystophora* Nills., 1820, 382 (*cristata*); *Dasyprocta* Ill., 1811, 93 (*aguti*); *Didelphis* Linn., 1758a, 54 (*marsupialis*); *Erethizon* F. Cuv., 1822, 432 (*dorsata*); *Felis* Linn., 1758a, 41 (*catus*); *Gulo* Pallas, 1780, 25 (*gulo*); *Halichœrus* Nills., 1820, 376 (*grypus*); *Lepus* Linn., 1758a, 57 (*timidus*); *Lynx* Kerr, 1792, 32 (*lynx*); *Mus* Linn., 1758a, 59 (*musculus*); *Myrmecophaga* Linn., 1758a, 35 (*tridactyla*); *Nasua* Storr, 1780, 35 (*nasua*); *Ovibos* Blainv., 1816, 76 (*moschatus*); *Phyllostomus* Lac., 1799, 16 (*hastatus*); *Procyon* Storr, 1780, 35 (*lotor*); *Putorius* Cuv., 1817, 147 (*putorius*); *Rangifer* H. Smith, 1827, 304 (*tarandus*); *Rhinolophus* Lac., 1799, 15 (*ferrum-equinum*); *Rupicapra* Blainv., 1816, 75 (*rupicapra*); *Sciurus* Linn., 1758a, 63 (*vulgaris*); *Sorex* Linn., 1758a, 53 (*araneus*); *Vespertilio* Linn., 1758a, 31 (*murinus*).

C. W. STILES.

U.S. Public Health Service,
Washington, D.C.

von Zeipel's Red Star near M 37.

THE very red star in the outlying regions of Messier 37 referred to in the Astronomical Column of NATURE of June 14, p. 870, was brought to our attention some years ago by Prof. v. Zeipel as an object of unusual interest.

Three polar comparison photographs in March and September 1921 gave a mean photovisual magnitude of 12·86, in exact agreement with v. Zeipel's result in *Astr. Nach.* 5288. Two polar comparisons made with ordinary plates on September 6 and 8, 1921, gave for the photographic brightness 17·75 and 17·95 respectively. The latter values are not very trustworthy, because the images were near the limiting magnitude of the plates; but the mean, 17·85, should be within 0·2 of the true photographic magnitude on the international scale.

The provisional colour index is, therefore, 5·0 mag. The ratio of the integrated intensity of the photovisual region of the star's spectrum (approximately λ5000 to λ6000) to that of the region to the violet of λ5200 is accordingly about 100 times the corresponding ratio for an A0 star.

FREDERICK H. SEARES.

Mount Wilson Observatory,
Pasadena, California, July 25.

A Biological Study of Radiation.

THE review of the second edition of our book, "Radium, X-rays, and the Living Cell," under the above title in NATURE of July 26 cannot pass without comment from us. One out of the two columns devoted to this review is a dissertation by the reviewer on the avoidance, by suitably directed regime and feeding, of the ills that fall to the lot of civilised man, including complaints such as cancer, dyspepsia, gastric and duodenal ulcer, gallstones, appendicitis, etc. We think that the natural inference of your readers will be that we have been writing on these matters; but we have neither written on this subject, nor do we subscribe to the opinions of the reviewer. Our efforts in producing the second edition of this book have, as in the first edition, been devoted to bringing together the chief experimental facts which have been ascertained of the effects which the rays from radium and X-rays have upon living organisms, and discussing very briefly any generalisations which may be possible on these facts.

HECTOR A. COLWELL.
SIDNEY RUSS.

Cancer Research Laboratories,
The Middlesex Hospital, W.1,
July 29.

Tropical Colonisation and the Future of Australia.[1]

By Prof. J. W. Gregory, F.R.S.

In North America the presence of the Negro has introduced problems of inscrutable perplexity; in South America a mixed race is in firm possession; in Africa as a whole the white man has no chance as a colonist; and in South Africa his future depends on some complex measure of segregation. In Asia, only in the north and north-west has the white man any prospect of permanent dominion. In contrast to these restrictions, in Australia the fundamental problem is the possibility of the occupation of the whole continent by the European race.

When the chief inrush of immigrants into Australia occurred after 1850, the belief was almost universal that the natural home of the white man was in the temperate zones and that the torrid zone must be left to the coloured races. That policy was accordingly adopted by Australia and pursued for fifty years. The tropical districts were left open, with varying limitations, to Asiatic immigration. Few Asiatics, however, took advantage of this opportunity, though large numbers were eager to enter the cities and settlements in the south, where the European had done the pioneer work. In the north the Asiatics were a hindrance, as they were too few to help materially, and they were sufficient to discourage the entrance of white artisans.

In 1901 Australia, on federation, found itself faced by two problems—the empty north which the open-to-Asia policy had not filled, and the disturbing effect of indentured coolies on white labour. The policy of excluding coloured people and working the northern plantations with white labour was declared to be a physical and physiological impossibility. In 1907, in opposition to this traditional view, I remarked ("Australasia," i. p. 15) that "medical authorities on tropical climates seem now, however, to be coming to the opinion that this view is a popular prejudice which does not rest on an adequate foundation." The evidence to that effect had been stated in a remarkable paper by Dr. L. W. Sambon, and endorsed by the late Sir Patrick Manson, and has been supported by the general trend of medical opinion during the past seventeen years.

The general distribution of mankind is in such close agreement with the rule that the white race has settled in the temperate regions and left the tropics to the coloured races, that any policy inconsistent with that arrangement must be prepared to encounter a strong prepossession to the contrary. Nevertheless, that rule is inconsistent with so many facts that it is not a safe basis for a national policy. In America, for example, the whole continent, except for the Eskimo in the north, was occupied by dark-coloured Mongolian tribes, in which, according to Flower and Lydekker ("Mammals," 1891, p. 752), "the colour of the skin, notwithstanding the enormous difference of the climate under which many members of the group exist, varies but little." The most northerly part of Europe is occupied by a coloured race, the Lapps. In Africa the darkness of the skin does not always vary in accordance with distance from the Equator.

[1] From the presidential address, "Inter-Racial Problems and White Colonisation in the Tropics," delivered to Section E (Geography) of the British Association at Toronto on August 7.

Supposed Unfavourable Factors in Tropical Climate.

(*a*) *Heat.*—The belief in the unsuitability of the tropics for the white man rests on several considerations. Most importance is naturally attributed to the heat, as that is the essential difference between the tropical and other zones. Intense heat is regarded as injurious to people not protected by a dark skin. That view overlooks the automatic process by which the living body adjusts itself to temperatures even higher than occur in any climate on earth, and that would quickly cook it, if dead. During some experiments by Sir Charles Blagden in 1774, Sir Joseph Banks remained in a room for seven minutes at a temperature of 211°; and Blagden subsequently stayed at the temperature of 260°, while eggs were roasted hard and beefsteaks cooked in a few minutes. White men work in furnaces and bakeries at 600° F., and if they can survive such temperatures even for short spells, they should be able to withstand the hottest climate on earth.

That heat is not the dangerous factor in the tropics is obvious from the well-known fact that the hottest areas are often the healthiest. Agra is hotter and healthier than Bombay, and the summer heat of Colorado is fiercer than that in the less healthy Mississippi Valley.

(*b*) *Moist Heat.*—As dry heat affords no explanation of the high mortality of some tropical localities, appeal was made to moist heat, and to the combination of heat and moisture marked by a high wet bulb temperature. At any temperature above blood heat the body is cooled only by the evaporation of perspiration, which does not take place in air saturated with moisture. Hence in the Townsville experiments a man placed in a room in which the wet bulb temperature rose from 98° to 102°, fainted in forty minutes. In a hot locality a dose of atropin, which suppresses perspiration, may be quickly fatal.

A wet bulb temperature higher than blood heat would be fatal to men, white or black; but no earthly climate has such temperatures. It was at first suggested that the limit of human activity was the wet bulb temperature of 73°, but there are well authenticated records of miners working for four-hour spells for months at the wet bulb temperature of 80° to 90° in Hongkong, the Straits Settlements, Beaufort in Borneo, and Ocean Island in the Pacific. At all these places people, both white and coloured, survive these conditions. Hence the limit has been gradually raised and it is recognised that men can withstand wet bulb temperatures of 85°, though the power of work under such conditions is necessarily greatly reduced. The highest wet bulb temperature mentioned in Dr. Griffith Taylor's record at Port Darwin is 81°. The wet bulb data for North Australia are scanty; but there seems no reason to expect that any considerable areas have a more uncomfortable climate than Calcutta, to which Dr. Taylor compares the worst localities of tropical Australia. Calcutta is one of the healthiest cities in India, and has a large and vigorous European population, many of whom spend there the whole year.

Moist heat is trying and must be considered in judging

climates from the standard of comfort and personal efficiency. The investigation of wet bulb temperatures, the significance of which was shown by Sir John Haldane, has been developed in reference to the textile industries by Dr. Leonard Hill and Dr. Boycott, to mining by Sir John Cadman, to the conditions of tropical Australia by the work of Prof. Osborne and has been illustrated by the ingenious climographs of Dr. G. Taylor; it has yielded results of high practical value. But the wet bulb isotherm does not delimit the areas where the white man may live and work, and does not really affect the question of white *versus* black colonisation, as there does not seem to be any reason to believe that black men could withstand a higher wet bulb temperature than white men. In answer to an inquiry on this question, Sir John Haldane replied that his impression on the contrary was that "white men can usually stand more heat than black men," and he reported the information given him that in places like the Red Sea the Clyde stokers stand the heat better than the Lascars, "and, in fact, have constantly to carry the latter out and lay them on deck to cool."

(*c*) *Monotony in Temperature.*—Another temperature factor that has been appealed to is that depressing equability of temperature which occurs on some tropical coasts. Excessive monotony in the weather is no doubt depressing, and temperature changes have a stimulating beneficial effect. Extremes of cold and heat are still more inconvenient and trying, and a moderate equability is often advertised as an attractive feature in a climate. The equability of the oceanic climate is recognised as most favourable for many conditions of health. The areas over which extreme uniformity of temperature prevails throughout the year are, however, so restricted that this factor does not affect the problem of tropical settlement as a whole. With the exception of low tropical islands, places with monotonously equable climates are in positions whence a change may be secured by a visit to some neighbouring hill country.

(*d*) *Actinic Rays.*—A fourth factor to which much importance has been attached in connexion with the tropical climate is the effect of the chemical rays of the sun. Great importance was once attached to the pernicious influence of the ultra-violet chemical rays of the sun on persons not protected by a dark skin. Residents in the tropics were therefore advised to line their clothes with orange-coloured fabrics to shield themselves from the chemically active rays. These views reached their extreme in the writings of Surgeon-Major C. E. Woodruff in 1905, who held that the actinic rays of the sun are so inimical to the white man that they inhibit his permanent settlement within 45° of the Equator. He therefore regarded the tip of Patagonia as the only area in the Southern Hemisphere fit for white occupation. The temporary stagnancy of the population of Australia after the droughts of 1900–1902 he regarded as evidence that the native-born white Australian and delicate New Zealander were wasting away through physical decay due to the enfeebling sunshine, just as the health of American and European children was being ruined by the "daft" practice, as he called it, of flooding schoolrooms and nurseries with streams of light. Woodruff's conclusions have naturally been disregarded.

Any deleterious effects of the chemical rays of the sun may be avoided by the use of appropriate clothes, and physical considerations suggest that a black skin should afford less protection than a white skin. Any injury that may be wrought by powerful sunshine, according to Aron's work in the Philippines, is due to the heat rays at the red end of the spectrum and not to the chemical rays. The modern lauded system of heliotherapy is based on the belief that strong sunshine is a powerful curative agency.

(*e*) *Miscellaneous Factors.*—The four previously considered factors have the advantage that they can be readily understood and tested; but as they have failed to provide any basis for the unsuitability of the tropics for the white man, the appeal has been shifted to a complex of tropical influences, including a rise of body temperature, the lessened activity of lung and kidney, and nervous disturbances. Dirt and disease and carelessly prepared food are also mentioned, though they are due to human agencies. The physiological effects of the tropical climate in this indictment are contradicted by high authorities. The rise in body temperature is emphatically denied amongst others by Breinl and Young from observations in Queensland, and by Chamberlain on the basis of extensive observations on American soldiers in the Philippines. A slight rise may occur in passing from the temperate regions to the tropics, but it is soon recovered; and Shaklee reports from his experiments on monkeys at Manila that "the healthy white men may be readily acclimatised to the conditions named—that is, to the tropical climate at its worst." Shaklee adds that the most important factor in acclimatisation is diet.

The asserted ill-effects of the tropics on respiration appear to have no more solid basis. Prof. Osborne found at Melbourne that the rate of respiration was increased on the hottest days, and his observations agree with those of Chamberlain in Manila. So far from the tropical conditions being injurious to the kidneys, it is asserted, as by Dr. A. B. Balfour, that there is less trouble with that organ in tropical than in temperate climates. The apparently inconsistent observations on the action of the kidneys between various tropical localities and people may be explained by differences in diet.

The remaining charges against the tropical climate are insignificant, or not based on climatic elements, or are indefinite. Some of the alleged factors are trivial, such as the liability to various skin diseases owing to change in the skin reaction; for if the white man allows himself to be kept out of any country by such a cause he does not deserve to get in. The hygienic troubles due to association with an insanitary people are sometimes adduced; but they are not an element in climate and would not operate in a land reserved for white people. The remaining factors rest on ill-defined nervous ailments which are more likely to be due to domestic difficulties than to climate. These nervous troubles fall mainly on the women who have the strain of disciplining native servants into conformity with British ways. Nervous disorders are said to be worst in hot, dry, dusty regions which in the tropics are generally regarded as the most healthy, except to those whose constitutions require a moist atmosphere.

Medical opinion has gone far towards the general adoption of the conclusion that there is nothing in

climate to prohibit the white man from settling in the tropics.

As an example of a recent authoritative verdict may be quoted the report of a sub-committee appointed in 1914 by the Australian Medical Congress to investigate the medical aspects of tropical settlement. After extensive inquiries, the comparison of the blood of children born and bred in the tropics with those of the temperate regions, and other evidence, the sub-committee reported in 1920 as follows: "After mature consideration of these and other sources of information embodying the results of long and varied professional experience and observation in the Australian Tropics, the sub-committee is unable to find anything pointing to the existence of inherent or insuperable obstacles in the way of the permanent occupation of Tropical Australia by a healthy indigenous white race. They consider that the whole question of successful development and settlement of Tropical Australia by white races is fundamentally a question of applied public health in the modern sense. . . . They consider that the absence of semi-civilised coloured peoples in Northern Australia simplifies the problem very greatly."

Improvements by Public Sanitation.

The trend of medical opinion to the view that there is no physiological reason why the white race should not inhabit the tropics may lead to a change similar to that regarding some localities in the temperate zones, which were formerly regarded as death-traps and are now popular health resorts. The island of Walcheren, on the coast of one of the most densely peopled countries in Europe and only thirty miles from so fashionable a watering-place as Ostend, had, a century and a quarter ago, one of the most deadly climates in Europe. The largest army which had ever left the British islands landed there in 1809. Napoleon did not think it worth powder and shot. "Only keep them in check," was his order, "and the bad air and fevers peculiar to the country will soon destroy the army." Napoleon's judgment was justified. The force of 70,000 men disembarked on July 31 and August 1. By October 10, according to Sir Ranald Martin, 142 per thousand were dead of disease, and 587 per thousand were ill.

Algeria is now a trusted sanatorium. Yet disease annually swept away 7 per cent. of the French army that conquered it. Sir A. M. Tulloch remarked that if the French Government had realised the significance of that mortality "it would never have entered on the wild speculation of cultivating the soil of Africa by Europeans, nor have wasted a hundred millions sterling with no other result than the loss of 100,000 men, who have fallen victims to the climate of that country." The same change of view has taken place in reference to some tropical localities. The deadliness of the Spanish Main to our armies was described by Samuel Johnson. "The attack on Cartagena," he said, "is yet remembered, where the Spaniards from the ramparts saw their invaders destroyed by the hostility of the elements; poisoned by the air, and crippled by the dews; where every hour swept away battalions; and in the three days that passed between the descent and re-embarkation half an army perished. In the last war the Havanna was taken, at what expense is too well remembered. May my country be never cursed with such another conquest." Yet Havana, under American administration, has become one of the healthiest cities in the world.

Sir John Moore, when Governor of St. Lucia (1796), wrote home that it is not the climate that kills, but mismanagement. His insight has been demonstrated in the same region. The French attempt to build the Panama Canal was defeated by disease. Discovery of its nature enabled the late Surgeon-General Gorgas to secure for the 10,000 men, women, and children in the canal construction camps, in spite of the high humid heat, as good health as they would have had in the United States. Gorgas claimed that the results at Panama "will be generally received as a demonstration that the white man can live and thrive in the tropics." Gorgas realised that the results for the future are even more momentous. He predicted that as "the amount of wealth which can be produced in the tropics for a given amount of labour is so much larger than that which can be produced in the temperate zone by the same amount of labour, that the attraction for the white man to emigrate to the tropics will be very great when it is appreciated that he can be made safe as to his health conditions at small expense. When the great valleys of the Amazon and of the Congo are occupied by a white population, more food will be produced in these regions than is now produced in all the rest of the inhabited world."

The Development of Tropical Australia.

The experience of colonisation in tropical Australia is limited to about seventy years; but it affords no ground for the expectation that the ultimate effects on the white race will be detrimental.

(*a*) *Vital Statistics in Queensland.*—In Queensland, most of which is tropical, the death-rate is lower than in any European country and is lower than in most of extra-tropical Australia. In the six years 1915–21, according to the statistics in the Australian Year-book (No. 15, 1922, p. 99), the crude death-rate in Queensland was the lowest in the six Australian States for one year, and fourth of the six States in three years, and the fifth in three; it was not once the highest. In the same six years the infantile death-rate was lowest in Queensland in three years, and the second lowest in two others. According to the same authority, by Index of Mortality (*i.e.* the death-rate in proportion to the ages of the community), Queensland was in 1921 the second State in order of merit, being inferior only by 0·03 to New South Wales, the State most favoured in this respect.

The physical vigour of the Queenslander is shown by his athletic prowess, and by the low rejection-rate of recruits from that State for the Citizen Army. The longevity in Queensland may be judged by the experience of the life assurance offices. It has often been asserted that assurance rates show that tropical climates are unhealthy. Yet the chief actuary for the greatest Australian assurance company, the Australian Mutual Provident Society, reported to the Committee of the Australian Medical Congress, "I have no hesitation in saying that as far as we know at present there is no need for life assurance offices to treat proponents who live in North Queensland differently from proponents who live in other parts of Australia."

Physical and mental degeneration in a people living

under unfavourable conditions would probably be most readily observed in the children. To use this clue I asked the Queensland Education Department whether its inspectors had noticed any unfavourable symptoms among the children in the most tropical of its northern schools. The Department replied that on the contrary its schools at Cairns and Cooktown, two of the most northern towns, are exceptionally efficient, and one of them is sometimes the leading school in the State.

(*b*) *Northern Territory*.—The great success of Queensland, although more than half the State is within the tropics, renders the more striking the failure of the adjacent Northern Territory of Australia, of which the records are disappointing. Agriculture has declined; the Government demonstration farms have been reduced to native reserves; the meat works have been closed; the population has fallen in numbers; and mining production has become insignificant. The present state of the Territory has been adduced as evidence of the futility of trying to develop a tropical land by white labour. Its failure was not, however, due to the White Australia policy, which was introduced after the failure was complete, but to geographical disadvantages not yet surmounted. The Territory, before 1901, was open to Asiatic immigration, but the hope that it would be adequately peopled from Asia was not fulfilled. Poorness of soil, unsuitable distribution of rainfall, and inaccessibility of position explain its backwardness. Great hopes are based on cotton, but its profitable cultivation appears dependent upon the establishment of a protected cotton manufacture in Australia, which would secure a market for the crop at a price that would pay for the high cost of picking. The remedy for the failure lies not in another attempt with Asiatics, but in the removal of the isolation of the Territory.

(*c*) *Queensland and the Sugar Industry*.—Queensland in contrast to the Northern Territory has made firm progress; the population has continued to increase; and though at first coloured labour was introduced, the proportion of the Asiatic population in 1911 was only 1·47 per cent., and of the Polynesian only 0·29 per cent.

The numbers of coloured labourers in Queensland were too small seriously to affect the population, but they were sufficient to be a constant irritant and source of uncertainty in the local labour market. This trouble led, in 1900, to the prohibition of indentured coolie labour throughout Australia. This decision was supported by the great majority of the Queensland people in spite of the most emphatic warnings of disaster.

The Australian adoption of white labour for its sugar plantations has been the greatest contribution yet made to the practical solution of the problem whether the white man can do agricultural work in the tropics. The experiment shows that white labour can be employed successfully in such an ultra-tropical industry as sugar cultivation in even the ultra-tropical climate of the Queensland coastlands, provided the settlers are protected from infectious disease and from the competition of people with lower standards of life.

DRAWBACKS OF THE TROPICAL CLIMATE.

The conclusion that white settlement of the tropics is possible should not lead to the drawbacks of a tropical climate being overlooked. The conditions where the wet bulb temperatures are high are uncomfortable and unfavourable to mental and physical activity. People who are not keenly interested in their work should avoid the tropics. Ellsworth Huntington in a valuable series of works has directed attention to many facts which show the dependence of Western civilisation on the stimulating nature of the temperate climate, for the frequent changes in temperature and wind are conducive to alertness and general efficiency.

The enervating effect of the tropical climate is no doubt counterbalanced by various compensations. Man needs less in food, fuel, clothing, and housing, while the same amount of exertion will produce a more luxuriant and valuable crop. The supremely fertile tropical regions have, however, usually a hot muggy climate, which is not attractive to Europeans while areas with less trying conditions are available. Northern Australia, even if it were not hampered by a high proportion of poor land, would naturally develop slowly, just as in Canada the Northern Territory and the rocky backwoods have lagged behind the St. Lawrence basin and the rich-soiled western plains.

CONCLUSION.

The conclusion that the white man is not physiologically disqualified from manual labour in the tropics and may colonise any part of Australia simplifies inter-racial problems, as it provides an additional outlet and spacious home for the European race.

The preceding survey of the position where the three main races meet in intimate association indicates that the world will have a happier and brighter future if it can avoid the co-residence in mass of members of the different primary divisions of mankind. Individual association and contact should secure for each race the benefit of the intellectual, artistic, and moral talents of the others; while industrial co-operation should aid each nation to make the best use of the land in its care.

The world has reached its present position by the help of each of its three great races, and it still needs the special qualities of each of them. The contemplative Asiatic founded all the chief religions, the ethical basis of civilisation. The artistic Negro probably gave the world the gift of iron, the material basis of civilisation. The administrative genius of the European race has organised the brain power of the world to its most original and constructive efforts. The affectionate, emotional Negro, the docile, diligent Asiatic, and the inventive, enterprising European do not, however, work at their best when associated in mass. That association is attended with serious difficulties; for race amalgamation, which is the natural sequel, is abhorrent to many nations, and the intermarriage of widely different breeds, according to many authorities, produces inferior offspring. The policy of co-residence with racial integrity has failed to secure harmonious progress in North America and South Africa. The development of the best qualities of the three races requires their separate existence as a whole, with opportunities for individual association and co-operation.

In view of the inter-racial difficulties that have developed wherever the races are intermingled, Australia will throw away a unique opportunity if it fails to make a patient effort to secure the whole continent as the home of the white race.

A Philosopher on Relativity.

By Sir OLIVER LODGE, F.R.S.

AT the twenty-third annual meeting of the Eastern Division of the American Philosophical Association, held at Brown University, Providence, R.I., in December 1923, a presidential address on "The Einstein Theory and a Possible Alternative" was delivered by Prof. William Pepperell Montague, professor of philosophy in the Columbia University of New York. In this address Prof. Montague shows himself to be a philosopher rather especially interested in physics; and he claims the advantage of having discussed certain aspects of the subject with Prof. Bergen Davis and other members of the physics department at Columbia. He reviews and criticises parts of the Einstein theory in a lively manner, thereby arousing interest among philosophers; and his contentions are deserving of notice.

Apparently Prof. Montague raises no objection to Einstein's General Theory, so far as it deals with matter and gravitation, and so far as it replaces the idea of force by the idea of space-curvature. He seems to consider these apparently diverse ideas as only different methods of expressing the same thing; much as you might say that it does not matter whether you represent an ellipse by drawing it, or by writing $x^2/a^2+y^2/b^2=1$. Both modes of expression represent the same thing. Some might hold that a picture is a nearer approach to reality than a formula, but both call up relevant ideas in the mind. Moreover, a picture,—which regarded from a strict point of view is millions of molecules of one substance superposed upon billions of another,—must depend helplessly on the human mind for recognising in it any of the properties of an ellipse!—must, in fact, depend just as much on mind for its interpretation as does the algebraic convention. After all, as regards precision of measurement, the mathematical rather than the pictorial presentation is the more explicit and accurate of the two.

I must make it clear that Prof. Montague expresses appreciation of pure mathematics and feels no philosophical objection to those more striking and revolutionary ideas of Einstein which were borrowed from the pure mathematicians. In the geometrical way of regarding matter and force, the infinite finiteness of the universe, the representation of impenetrable specks of matter as impassable distortions of space,—in all this Prof. Montague rather rejoices; as the following extracts will show:

". . . bodies moving with accelerated velocities are subject to forces, hence the later Einstein theory consists, first, of a new though Cliffordian conception of the nature of *force*; and, second (growing out of that), of a new though Riemannian conception of the *universe itself*, as a domain at once boundless and finite. . . .

"Some will undoubtedly feel stifled and penned in at the thought that if they were to travel in a 'straight' line for only a few septillions of miles they would find themselves on the way home without ever having turned around. Others will find the new Riemannian hyper-sphere large enough for all practical purposes; and they will delight in the possibility of relating in some curious way the curvature or size of the universe as a whole to the dimensions of its minimum elements."

Prof. Montague does not think that the hyper-geometrical conceptions of reality need be upset by what he urges as failure in the simpler basis on which the original doctrines of relativity were founded—doctrines admittedly not so well established by actual *ad hoc* observation of predicted results as those of the more general theory have been.

"It is not, I think, too inaccurate to say that while the Special Theory reduces geometry to physics and is offensively destructive and phenomenalistic in its conception of the world, the General Theory reduces physics to geometry and its tone and temper are rationalistic and constructive. The muddy prose of Hume and Mach gives place to the clear poetry of Riemann and Clifford."

Prof. Montague goes on to pay a tribute to the late Prof. Clifford, with which, as an old student and junior friend of that remarkable genius, I cannot but sympathise:

"It was Clifford, working under the inspiration of the new geometry of Riemann, who, I think, first suggested that matter could be conceived as a non-Euclidian wrinkle in space. . . . It is pleasant to think that Clifford, whose mind was of such rare beauty and who in his appreciation of spiritual values possessed what the musicians call a sense for absolute pitch, should have been the first to hold a conception which now seems destined to have most far-reaching consequences."

So it turns out that Prof. Montague's criticisms are directed, not at the more recondite parts of the subject so finely developed and expounded by Eddington, but at its foundations as ordinarily expressed. His main objection seems to be to the Larmor-Lorentzian law for the composition of velocities, and to the absolute constancy of the velocity of light as supposed to be measured by different observers. He objects also to this velocity being regarded as a maximum velocity which cannot be exceeded. His view is that light is not really emitted and abandoned to a stationary ether, as a water splash is abandoned by a ship, but that light is continually associated with the lines or field of force belonging to and moving with the source, —somewhat after Faraday's idea of ray vibrations; an idea which, in modified form, has obtained weighty support of late, and about which it is best not to be dogmatic.

There has been a conspicuous tendency, of late, to revolt against the simplicity of the undulatory theory. Something more than that is evidently wanted. And incidentally I may mention that Prof. Benedicks, of the Metallographic Institute of Stockholm, has written an immediately forthcoming small book called "Space and Time," in which he supports some modification of the emission theory. With a corpuscular theory in empty space, the Michelson-Morley experiment would raise no difficulty at all, and probably would never have been performed; for the velocity of light would depend on the motion of the source, and everything would be simple. A similar simplicity is aimed at by Prof. Montague. He does not indeed propose a corpuscular theory—he sees difficulties in that,—but

he is well aware that what he does suggest is quite alien, and indeed contrary, to the early parts of the Einstein theory. He adduces therefore simple imaginary experiments, akin to those so often appealed to by philosophic relativists, by which he thinks the Einstein view might be disproved. He realises the difficulty of doing anything effective with only two signalling observers, who must be dependent on inconclusive to-and-fro journeys, so he arranges a triangular duel, with a third observer, or rather signaller, equidistant from the other two.

Let there be two observers on the same parallel of latitude, with perfect signalling appliances and stop-watches, which, however they are affected by the rotation of the earth, must at least go at the same rate; and let there be a third signaller at the north pole, who by symmetry is able to establish simultaneity between the other two. At the word "Go!" from the pole, the two on the equator signal to each other, and time the interval between sending and receiving. Prof. Montague claims that, on the ordinary wave theory, and as he mistakenly seems to think on the Einstein theory, the one travelling to meet the signal should get it sooner than the one whom it has to overtake. For, as he says, even waves take less time to travel less distance,—. . . "even Einsteinian light travels a shorter distance in less time than it does a longer distance."

On the other hand, on a corpuscular theory there would be no observable difference, because the increased speed of the corpuscles from an ordinary source would compensate for the recession of their recipient. So both Prof. Montague and Prof. Eddington would, I presume, expect a negative result; and the experiment would not discriminate between them. Unless, indeed, it gave a positive result, to the chagrin of both, and the triumph of a common-sense view based on the behaviour of ordinary waves.[1]

It will be observed, however, that Prof. Montague has abandoned translation, as hopeless for his purpose, and has utilised rotation; and about rotation there has always been something with a tinge of the absolute about it, even in relativity doctrine. But whether it is necessary to make this admission, in order to safeguard a positive result from Prof. Montague's imaginary experiment, is very doubtful. His own attitude is hostile to waves in a stationary ether, as well as to the less intelligible doctrine that every observer, at all times, must measure the same velocity for light; he does not actually sustain or mention a corpuscular theory, as Prof. Benedicks does,—and as apparently the Swiss genius Ritz did,—but his postulated entanglement of the waves with the field of the source comes to somewhat the same thing.

Prof. Montague goes on to attack the composition of velocities in a more direct manner, and likewise ridicules several curiosities of time measurement, including queer tales by rapid travellers with return tickets, cited from Eddington and Weyl; but concerning the hypothetical slowing down of physiological processes by motion, and other humorous interpretations of certain equations, I am not myself seriously sympathetic enough to justify my trying to sustain them against criticism.

Incidentally I note that he has a long footnote in which, by means of to-and-fro north and south signalling compared with the result of similar east and west signalling, he claims that we might distinguish between Einstein and Lorentz,—whatever that may mean. It looks as if he thought that Einstein discarded the β factor representing the FitzGerald-Lorentz Contraction (introduced by Larmor in 1900, "Æther and Matter," p. 173 *et seq.*, and vigorously used by Einstein), while Lorentz admitted it. Either I misunderstand him here, or he makes a mistake.

The alternative which Prof. Montague seriously proposes to the relativity treatment of light is not the corpuscular theory,—for, as he says, "light is in almost all respects wave-like rather than corpuscular"—but it is this,

". . . that the medium or carrier of light waves is not a doubtfully existent ether-substance, but the certainly existent field of force which each electron and proton carries with it."

He thus desires to abolish a stationary ether, as Einstein does not, and claims that because an electric field is centred on its charged particle, it follows that when a charged particle moves, its field must move with it.

"The velocity *in* the field will be constant and absolute, but the velocity *of* the field has to be added to it."

Thus he tries to combine the advantages of the wave and emission theories in this respect. But the full treatment is not so simple; a great deal is known about the way in which a field moves, and he would find himself immersed in plenty of complexities, unless he discarded electromagnetic theory altogether.

Finally Prof. Montague proposes an experiment to test his crucial assumption, namely, that the velocity of light is affected by the motion of the source, and is not independent of it as it would be in a stationary ether and as it is in Einstein's theory. His proposed experiment depends on rotation, again; and, to summarise it briefly, it employs the idea that light from the sun's advancing limb ought to come to us quicker than from the receding limb. His proposed rotator is not the sun, however, but a mechanical cylinder, sphere, or disk, projecting light from opposite points of its circumference, through a couple of narrow slits or tunnels, on to a moving sheet of sensitive paper. The slits or narrow tunnels are carried by a pair of drums, which are separated by a considerable distance and are revolving about an axis at right angles to the main axis and parallel to the path of the two beams of light. (He makes these drums revolve in opposite senses, but that is surely a mistake or a needless complication.) It follows that if they are revolving quickly enough, the light may be unable to get through both slits, because of the time taken in the journey between them, and he claims that with increasing speed the fading of the spot from one beam should precede the fading of the other. His experiment therefore is really a Fizeau-like experiment to measure the velocity of light, or rather to compare the velocities from two oppositely moving sources without the use of a mirror or any return journey: the fading and disappearance of the traces on the photographic film at a certain

[1] May I direct attention to a clear pre-relativity description of all this class of problem, in an old volume of NATURE for 1892 (vol. 46, pp. 497-502, and also on pp. 164 and 165; the latter with a misprint of θ for ϵ in two places).

speed of rotation being looked for, and the times of fading compared. But presumably any mode of determining the velocity of light would serve: the essence of the experiment is not the mechanical details, which are crude, but the suggestion that it is possible to find a difference in the velocity of light according as it comes from the approaching part of a rotating wheel or from the receding part.

Well, that is a definite suggestion for experiment, if any one really thinks it likely (as I do not) that the velocity of light depends on the motion of the source: though it would seem as if measuring the velocity of light from an approaching and receding star would be more likely to decide the question. At any rate, the difficulties encountered by employing a non-terrestrial source would be of another order. Prof. Montague fears, however, that a final entanglement of the light in the fields of atmospheric matter might interfere with a correct determination of velocity from an astronomical source. It might also be argued that the known Doppler effect, depending on stellar advance and recession, gives a relative frequency accurately calculable on the basis of a constant velocity for light, and that to supplement this by the peculiarities of a projectile kind of light would be merely perturbing. To this he would doubtless reply that a fair and square initial consideration of light as projected from its source will give the Doppler effect and explain the M.M. result with perfect ease. He might also claim, perhaps, that his variety of ray-wave would evade the usual Foucault objection to emission theories, and might give the Fizeau result in dense substances as well. These things are not elaborated in his paper.

But now—seeking what can be politely said in support of any of his contentions—it must be admitted, I think, that the relativity explanation of the Doppler effect can be made to look as if it had a weak point. Algebraically it comes out right, of course, but it has too much the air of the ordinary explanation, which attributes an obvious meaning to $c \pm v$. The ordinary explanation, for an observer approaching a source, is simply that the observed frequency increases in the ratio

$$\frac{n}{n_0} = \frac{c+v}{c}$$

by simple composition of velocities: which is still Professor Montague's, and used to be everybody's, argument. But, with the relativity law for compounding velocities, deduced from Larmor's transformation, this so described ratio would be unity, and there would be no Doppler effect at all if it had to depend on an apparently changed speed of arrival of the waves. Relativity, however, does not attempt to proceed by compounding velocities for the purpose of explaining the Doppler effect: it knows that c cannot be added to or subtracted from, by anything a source or an observer can do; so it simply applies the Larmor-Lorentz transformation to the space and time periodicities of wave motion, and deduces algebraically

$$\frac{n}{n_0} = \sqrt{\left(\frac{c+v}{c-v}\right)}.$$

Neglecting v^2/c^2 this has the same value as the ordinary expression above, and no experiment yet made can discriminate between them. But am I wrong in imagining that a relativist would dislike writing it in that form and would prefer the expression

$$\sqrt{\left(\frac{1+v/c}{1-v/c}\right)}\ ?$$

For this, though identical, conveys no inappropriate suggestion of compounded velocities.

In conclusion, it is always satisfactory when controversialists can get up against a question of fact. Stripping it to bare bones, we may put these two questions:

(1) Does the velocity of light really depend on the speed of its source?

Wave theory, Einstein theory, ether theory, all say "no." Corpuscular theory answers "yes": and Prof. Montague's adopted conception of a ray vibration also, in his opinion (but as I think doubtfully), answers "yes."

(2) Does the measured or apparent velocity of light depend on the motion of an observer?

Corpuscular theory, and Prof. Montague's theory, reply, "Yes if the source is stationary," "No if the source is moving with the observer." Ordinary wave theory would say "Yes in any case," for what the source is doing does not matter; that can only affect wave-length, not speed. Einstein's theory would loudly say "No in any case": for if one could discriminate between motion of observer and motion of source, relativity as commonly stated would be upset, and attention to a stationary ether would be made inevitable. Experiment so far has declined to answer: for a to-and-fro journey involves squares and can be dodged. So then at present we have no discriminating reply, unless an answer in favour of Einstein is to be taken as implied by the general consistency and sufficiency of his theoretical results both old and new.

One who is impressed with the mysterious way in which the Larmor-Lorentz transformation thoroughly formulates all known results without any trouble or hesitation, and yet who is not helped thereby to form a clear physical conception of the process, might urge that to clinch matters an experiment is desirable which should aim at determining $c \pm v$; when v is the speed, not of source, but of observer. That is, an experiment is wanted which would measure the speed of an observer relatively to light, and therefore relatively to a stationary luminiferous medium. Direct determination of the velocity of light at different seasons of the year, by any method, would at first sight seem able to settle this question, provided an accuracy greater than one in ten thousand could be attained.

But consider this further. A fixed space-interval and a time-keeper constitute the real observer: the FitzGerald contraction does not depend on whether motion is positive or negative, nor does direction of motion affect the rate of a clock. Hence if the experiment is made now and six months hence, x/t will equal x'/t', and no difference in the speed c will be perceived.[2] That seems right from one point of view; and yet, physically, waves *ought* to travel down an ether stream quicker than up, unless group velocity has something objectionable to say.

To sum up the position, still in an interrogative

[2] Because $\frac{x'}{t'} = \frac{x/t - u}{1 - ux/c^2t}$, which equals c if $x/t = c$, and not otherwise.

manner without dogmatism :—change of frequency depends solely on relative motion of source and observer: combined motion of both through a medium does not affect frequency on any theory, so long as the motion is steady. Ordinary aberration is wholly and solely caused by motion of observer relative to path of ray. Is observed velocity of light dependent on motion of observer, too? The strength of the relativity position is that no way of performing the experiment is likely to give a positive result, unless truly relative motion is introduced, as by mounting the whole receiver on the end of a revolving arm; and questionably even then. The strength of the ether position is that a relative ether stream past fixed "stations," though undemonstrated, is at least not negatived by this or any other experiment, and may therefore nevertheless be a reality. A philosopher may be able to explain what "reality" means.

Obituary.

Dr. Robert Kidston, F.R.S.

By the unexpected death of Robert Kidston on July 13, palæobotany suffers an irreparable loss. Dr. Kidston was still at the height of his activity, and had probably never been busier in his life than when the end came. He was then in South Wales, engaged on his fossil investigations. Equally distinguished in systematic and structural palæobotany, Kidston was the veteran leader in his science, worthy to rank with the great continental masters, such as Zeiller, Grand'-Eury, and Nathorst, who had already passed away.

Robert Kidston was born at Bishopston House, Renfrewshire, on June 29, 1852. The family removed shortly afterwards to Stirling, where Kidston's life was spent. As a young man Kidston went into business in a bank, but his strong bent for natural history soon turned him towards scientific pursuits. About 1878 he attended botanical classes in the University of Edinburgh. He was then, and remained throughout life, a keen field botanist.

Kidston soon became interested in fossil plants, and his work met with early recognition, for, from 1880 onwards, the plant-remains collected by the Geological Survey of Scotland were referred to him. This gave him his first great opportunity.

In Kidston's work as a fossil-botanist two periods may be distinguished. From the beginning up to 1904 he was predominantly a floristic and stratigraphical palæobotanist, and so indeed he continued to be, but from 1904 onwards he further took a leading part in morphological and structural investigation, and expressed himself with a wise authority on the great questions of affinity and descent. His work in every field was remarkable for that sound judgment which has so generally characterised the best systematists.

From about 1880 a constant succession of papers on fossil plants was maintained; only a very few can be mentioned here. In 1886 Kidston was entrusted with the duty of preparing a catalogue of the Palæozoic plants preserved in the British Museum, a valuable work of reference in its time. Thus he was already recognised as our leading systematist in Palæozoic botany.

Kidston always took a special interest in the fructification of ferns and fern-like plants. A paper published in 1887, "On the Fructification of some Ferns from the Carboniferous Formation," proved to be of exceptional importance, for various reproductive organs described belonged, as Kidston afterwards showed, to the group of the Pteridosperms. Thus, in the case of *Neuropteris heterophylla*, of which he afterwards discovered the seed, the fructification described in 1887 turned out to be the male form.

The memoir on Lepidophloios (1892) is the leading monograph on that genus of fossil Lycopods. A paper on the various divisions of the Carboniferous rocks as determined by their fossil flora (1893) is a valuable contribution to the geology of that period. Two important memoirs on the fossil flora of the Yorkshire coal-field, on which he had already published a number of reports, appeared in 1896 and 1897. The second is of remarkable interest, as containing the first complete description of the cones of Sigillaria, and thus finally establishing the true nature of that long-disputed genus.

A general summary of the flora of the Carboniferous Period appeared in 1901–1902. This was written at a transitional time, when botanists had recognised the Cycadofilices as a class, but were still ignorant of their reproduction. Kidston's remarks do justice to the position at that date.

The second and more brilliant period of Kidston's work opens with his important paper on the fructification of *Neuropteris heterophylla* (1904). He was the first to demonstrate, by direct proof of continuity, that a fern-like plant of the Coal Age bore seeds. Previous evidence (only slightly antedating Kidston's discovery), however convincing, had been indirect. Kidston, in fact, was a pioneer in this field. A year later (1905) he published a preliminary note on Microsporangia in connexion with the foliage of Lyginodendron and was thus the first to identify the male organs of a "seed-fern." This was followed up in 1905 by his great memoir on the microsporangia of the Pteridospermeæ, a truly admirable work, showing a rare soundness of judgment in discussing the affinities of the newly discovered group.

A purely anatomical memoir on the internal structure of *Sigillaria elegans* (1908) was the first full and illustrated account of the structure of a ribbed Sigillaria. The work was extended to other species a year later.

Other papers on structural subjects dealt with new species of Dineuron and Botryopteris (early ferns) and with a new Lepidodendron from Pettycur, all of Lower Carboniferous age. Kidston had a special predilection for Lower Carboniferous plants, and was among the first to grasp the full importance of this fine flora.

One of Kidston's later memoirs on the fossil flora of the Staffordshire Coal-Fields (1914) includes a number of important discoveries, the most striking being perhaps the pollen-bearing organ of a new Neuropteris, very different from that of *N. heterophylla*.

The mere glance we have taken at a few outstanding papers may serve to show how Kidston's work illuminated every side of Palæozoic botany. His work was fully appreciated on the Continent and was by no

means confined to his own country. In 1911 appeared a fine volume on "Les Végétaux houillers recueillis dans le Hainaut Belge" containing various new genera and species. Another foreign work was his joint book with Dr. Jongmans on the Calamites of Western Europe, published by the Dutch Government. This is a huge monograph; the Atlas published in 1915 contains 158 fine plates. So far as the writer is aware, only a portion of the text has appeared.

It remains to notice briefly some of Kidston's work in conjunction with other botanists. One of his most valued colleagues was the late Prof. D. T. Gwynne-Vaughan, whose early death was so severe a loss to botany. Their work on the fossil Osmundaceæ, in five parts, ranging from 1907 to 1914, is a palæobotanical classic, tracing back the history of the Royal ferns from the Tertiary to the Permian. An admirable photograph is extant, showing the two collaborators at work together on this investigation. Other papers with Gwynne-Vaughan were on a Tempskya from Russia, by far the best account up to that time of this peculiar type of fern-stem, and on a Lower Carboniferous fossil, *Stenomyelon tuedianum*, discovered by Kidston. This is a model of anatomical work, concise, clear, and exhaustive.

Kidston's work in conjunction with Prof. W. H. Lang, on the Old Red Sandstone plants of the Rhynie Chert-bed (five memoirs, 1917–1921), was the most important of all, for it demonstrated, in full detail, the structure of the oldest land-plants of which we have any certain knowledge. Never was a great discovery more completely and wisely expounded. The simple plants of Rhynie, thanks to Kidston and Lang's researches, now form the basis of evolutionary work on the plant kingdom.

Other joint memoirs by the same authors were on Hicklingia, a new genus of Early Devonian Plants (1923), and on *Palæopitys Milleri* (1923), the famous but long neglected "cone-bearing tree" of Hugh Miller. The authors worked out the structure fully, but reserved judgment on the affinities of the plant, which is certainly of astonishingly high organisation for an Early Devonian horizon.

Kidston, at the time of his death, was engaged on what, from a floristic point of view, was to have been the greatest work of his career. This was nothing less than the full description and illustration of all the Carboniferous plants of Great Britain. The series, published by the Geological Survey, was planned to consist of ten memoirs but would, no doubt, have run to more. Four memoirs have been actually published, illustrated by 91 fine plates. They only embrace a portion of the ferns and fern-like plants. The systematic descriptions are illuminated by admirable observations on broader questions of affinity. It is understood that two more parts are sufficiently advanced for publication, and it is earnestly to be hoped that this magnificent work, a credit alike to the author and to the Department which undertook it, may eventually be brought to completion.

Kidston, among his other accomplishments, was a highly skilled photographer and was thus enabled to illustrate his own works, both systematic and anatomical, in a manner which adds immensely to their value and beauty. In all his writings Kidston showed himself a most fair and generous critic. His splendid collections both of impressions and sections were always available for the use of his scientific colleagues. The present writer, in particular, can testify how much he owes to the constant and generous help of his old friend.

D. H. S.

Prof. Alois Mrázek.

On November 26, 1923, died Dr. Mrázek, professor of zoology in the Charles' (Bohemian) University of Prague. He was born in 1868 in Příbram, and originally worked under A. Frič in the patriotic study of the fauna, the aim of which was to increase the knowledge of Bohemian fauna and the extension of the single genera. Later on, under the influence of his second teacher, Prof. Vejdovský, he devoted his study to typical problems of the period of classical morphology and cytology. He did not limit himself only to the discovery and description of new genera, but he was also interested in the problems, which are typical for the area, of the classical morphology and cytology.

Mrázek directed his study chiefly to the Crustacea and Copepoda, especially to the hermaphroditism of the first and the numerous anatomical details of the antennæ of the second, and the exactness of his work became known in foreign countries, from which valuable material was entrusted to him for research. He found cystercoids in copepods, and their study brought him to that of the complicated cycles of the evolution of helminthes, and so he became a co-editor of the *Journal of Parasitology* and a member of the Helminthological Society of Washington. He investigated also the Sporozoa, Planariæ, Oligochæta, and studied very deeply the life of ants, all work of great exactitude, and discovered fresh-water Nemertines in Bohemia, as well as the only representative of subtropical Temnocephalids in the Lake of Scutari. His beautiful drawings appear frequently in the larger works on cytology. Mrázek was a modern zoologist who was a master of the problems of his time, not a one-sided systematist or a mere morphologist. His work touched also problems of variability, heredity of acquired characters, regeneration, and he devoted a good deal of his time to the study of the relations between the organism and the medium in which it lives, to ecology.

Mrázek was a splendid teacher, full of sacrifice, especially in laboratory work. He published a series of popular lectures on the theory of evolution, and translated Romanes' work, "Darwin and after Darwin." He founded a small but pretty aquarium in his institute, which is visited by thousands of students and other people. While still living, he presented to his institute his rich private library and all his instruments, etc. He was a member of the Bohemian Academy of Science and of the Royal Society of Bohemia. His death is a great loss to our University.

Bohuslav Brauner.

We much regret to announce the death of Prof. P. Natorp, emeritus professor of philosophy in the University of Marburg, author of "The Logical Foundations of the Exact Sciences," and leader of the neo-Kantian school, aged seventy.

Current Topics and Events.

THE East African Parliamentary Commission has started on its long journey, a journey fraught with great and manifold possibilities. If any assurance was needed that scientific matters would receive their fair share of attention, it is to be found in the fact that Major A. G. Church, a member of the Medical Research Council, is one of the Commissioners. No such assurance is, however, required, for Mr. W. Ormsby-Gore, the chairman, is fully alive to the important part which scientific knowledge plays, and must continue to play, in the development of our tropical possessions. He has not forgotten the lessons learned in the West Indies, and realises that many of the same problems will be found in East Africa, together with others peculiar to what was once called the Dark Continent. Indeed, he and those with him are well aware that it is in the main owing to the triumphs of science that the old opprobrious title is no longer wholly applicable, but they are also persuaded that much more light requires to be shed on many difficult questions before the darkness which at present enshrouds them can be fully dispelled. Human, animal, and plant diseases will engage their attention. All three are closely linked, perhaps more closely linked in Africa than anywhere else in the world. Examples come readily to mind: there is human sleeping sickness and animal trypanosomiasis, which the Commissioners will find in every territory they visit, and one thinks also of the calamity of a heavy aphis infection of millet and the famine which may follow it, and of the desolation which locusts leave in their track and the dire effects of their inroad upon both man and beast.

WHILE certain human diseases—as, for example, sleeping sickness, malaria, tuberculosis, leprosy, dysentery, yaws, the venereal complaints, and so forth—will be found common to all the countries in which the East African Parliamentary Commission will prosecute its inquiries, there are others to which the Commissioners' attention will be particularly directed in certain localities. In Northern Rhodesia there have been many cases of splenic abscess amongst natives, an obscure condition requiring research; plague merits special attention in Nyasaland and Kenya Colony; while in Uganda cerebro-spinal fever causes many deaths amongst natives. Again, some of the general diseases are more serious in certain territories than in others. Yaws is a crippling force in Kenya, syphilis a devastating disaster in Uganda. All these questions will require consideration, as will those of native hygiene generally, a subject intimately bound up with housing conditions and therefore with technical education. Veterinary problems abound, and in connexion with them and with many plant diseases the necessity for entomological research will be apparent, as indeed is also the case with respect to human pathology. It will be seen that on the scientific side alone there will be plenty to engage the Commission's attention. It cannot deal with details, but if it grasps some of the great underlying principles and speaks eventually with authority as to the necessity of increased facilities for education and research and for coping with disease and death, it will not have travelled and laboured in vain.

THE Government has decided to proceed at once with certain preliminary investigations in order to ascertain the feasibility of the scheme for using the tidal power of the River Severn for the production of electrical power by the erection of a barrage across the river. Lord Parmoor, to whose scientific department (the Department of Scientific and Industrial Research) the work has been entrusted, has already made arrangements to put it in hand. The Lord President of the Council has appointed the following Committee to supervise and direct the work:—Mr. G. S. Albright (chairman), Prof. A. H. Gibson, Mr. G. W. Lamplugh, Mr. Maurice Wilson, and Dr. J. S. Flett. The feasibility of the Severn scheme turns upon the possibility of finding satisfactory foundations for a barrage. Accordingly the first stage of the investigation will involve:—(*a*) The study by the Geological Survey of the stratigraphical formations in the neighbourhood of the sites suggested for the erection of the barrage; (*b*) taking preliminary soundings with the view of determining the contour of the river-bed at the sites; and (*c*) preliminary measurements of the flow of water at different states of the tide. Meanwhile, two eminent consulting engineers, Sir Maurice Fitzmaurice and Sir John Purser Griffith, have been invited by the Lord President to submit a joint report before the end of this year as to the possibility of constructing a barrage on one or more of the sites suggested on the assumption that safe foundations exist. The data which will be provided as a result of the geological and hydrographical investigations will be placed at their disposal. The staff of the Geological Survey has already begun the inquiry, and a report will probably be ready for submission to the Committee before the end of September.

BETWEEN 11 and 12 P.M. on August 22, a slight earthquake (intensity 4, Rossi-Forel scale), which lasted about six seconds, and was followed by another after an interval of about a minute, was felt in Inverness-shire, at Gairlochy, Spean Bridge and Roy Bridge, all within a few miles of the Great Glen fault. This fault, which runs from Tarbat Ness and crosses Scotland along the line of the Great Glen, has given rise to earthquakes in several parts of its course. Shocks are strongest and most frequent in the section between Inverness and the north-east end of Loch Ness, the last series being those of 1901. From 1870 to 1906, at least seven shocks occurred in the neighbourhood of Fort William, and it is possible that the strong Oban earthquakes of 1880 and 1907, as well as other slighter movements farther to the south-west, were connected with this fault. But, so far as known, this is the first time that an earthquake has originated near the south-west end of Loch Lochy

We are interested to learn that Mr. Joseph F. Rock, head of the National Geographic Society's expedition into Yunnan, S.W. Szechuan and S.E. Tibet, has recently returned to the United States after eighteen months in the field. He reports the finding of aboriginal tribes in China practising religious ceremonies which existed before Buddhism was introduced into either China or Tibet. He also brought back important plant and bird collections, the herbarium specimens numbering some 12,000 specimens. The plants were collected in the extreme north-west of Yunnan, Tsarong, south-eastern Tibet, the independent Lama Kingdom of Mili and also in eastern Yunnan. The birds collected number about 1600, and are from regions where few collections had previously been made. The collection contains land and water birds, and in addition a few hundred mammals. The birds and mammals will be presented to the Smithsonian Institution. Chestnuts of apparently immune species were found which may prove of value in the United States where the chestnut disease has wrought such havoc. Mr. Rock's chestnut introduction should prove of great interest to the tanning industry in the United States, which has depended upon chestnut to a great extent and has recently faced the possibility of this supply being destroyed through the ravages of blight. A fine set of firs, spruces, hemlocks, pines and junipers were also brought back. A large collection of rhododendron seeds was made, amounting, it is stated, to 493 kinds, and specimens of many of the rhododendrons as well as seeds of these and of Alpine plants have been sent to Kew and to Edinburgh.

In his presidential address to the Society for Psychical Research, just published, Mr. J. G. Piddington emphasised the difference between the certainty of astronomical predictions and the certainty of the psychical phenomena studied by the Society by saying that the Astronomer Royal, if he wished, could safely wager 5000*l*. to 1*l*. that an eclipse would take place at a certain time, whereas no such wager would be safe in, say, a case of alleged telepathy or clairvoyance. The comparative immunity from such uncertainty enjoyed by most men of science, he said, might actually disqualify them from being the best judges of the Society's work. The best policy would be to aim at convincing the average educated person. One of the difficulties lay in the fact that every science tended to become more and more complex, and those members of the Society who did not keep pace with the development of their methods were inclined to lose interest in their proceedings. Thus the latest automatic writings of some of their members were a sort of elaborate and extensive mosaic, a galaxy of cross-correspondences. In Mr. Piddington's opinion, this greater complexity arose from *someone's* intelligent design, though he would not venture to trace the intelligence which was deliberately complicating some of the phenomena investigated by the Society The greater danger was a wave of credulity and superstition. The cause of psychical research stood to lose more through the credulity of the crowd than through its indifference or its scepticism.

The Council of the Zoological Society of London has instituted an Aquarium Research Fellowship of the annual value of 350*l*., tenable for one year, but with the expectation of reappointment for two further years if satisfactory progress is being made. The Research Fellow will be expected to give his whole time to his investigations, which will be carried out chiefly at the Aquarium in the Zoological Gardens. The object of the research is study of the conditions which affect the life of the organisms living in an aquarium, and not the anatomy, physiology, or life-histories of individual organisms. Candidates should be recent graduates in honours in some branch of science, and should be recommended as likely to carry on research on independent lines. Experience of marine or fresh-water zoology is not required. Inquiries should be addressed to the Secretary, Zoological Society of London, Regent's Park, London, N.W.8. It is not expected that an appointment will be made before October 15.

Dr. Fraser Harris, acting on medical advice, has resigned the professorship of physiology in Dalhousie University, Halifax, Nova Scotia, which he has held since 1911.

During last week, an unusual contest was in progress at the Crystal Palace, where Mr. C. W. Hart pitted himself against a horse, Saucy Lassie, in an endurance test. The test, which was to see which could cover the greater distance in six days, came to an end on Saturday, August 23, when the total distances covered were: The man, 345 miles 880 yards; the horse, 337 miles 1618 yards. Mr. Hart was thus the winner by 7 miles 1022 yards.

A physicist is required under the directorate of radiological research of the Research Department, Woolwich. Candidates must possess an honours degree in physics and at least three years' experience in research. Applications in writing, with testimonials and references to published work, should be made to the Chief Superintendent, Research Department, Woolwich, S.E.18.

Dr. W. J. Humphreys, of the U.S. Weather Bureau, Washington, would be glad if any observers of "ball lightning" would send him a complete description of the phenomenon with the following details: date, witnesses, geographical position, time during the storm, size, shape, sharp or blurry outline, whether with or independent of wind, direction of motion (vertical, inclined or horizontal), kind of motion (smooth or jumpy), effects produced, indoors or outdoors, and if the former how it entered.

A preliminary programme has now been issued of the centenary celebration of the Franklin Institute and the inauguration celebration of the Bartol Research Foundation, to be held in Philadelphia on September 17-19. The Franklin Institute has helped in no small measure in the prosecution of research into physical science and its applications during the past hundred years, and a noteworthy gathering of physicists and engineers from both sides of the Atlantic is being brought together to celebrate the

anniversary. Among the British men of science who are to deliver addresses are Sir Ernest Rutherford, Sir William Bragg, Prof. W. L. Bragg, Prof. E. G. Coker, Prof. F. G. Donnan, Sir Charles Parsons, and Prof. J. S. E. Townsend. Other distinguished men of science, exclusive of the large body of Americans, who will be present, include Prof. Charles Fabry, Prof. F. Haber, Prof. W. Lash Miller, and Prof. P. Zeeman.

THE southern slope of the Grasberg, in the valley of the Dürren Ager, parish of Oberaschau, Austria, has been in motion. Portions of the forest have migrated to the valley, and landowners can no longer identify their own areas. One man has a piece of forest tipped on him, but the timber is not his; another has lost the meadows he intended to mow; they have slidden away. The area of the landslide is about 100 acres and is a quarter mile broad. The depth of the mass moved is not more than 50 feet, but it is not limited to the weathered surface. The whole slope has been soaked. Coloured or black clays and shales, dark grey "ruschel"-shales, interstratified between sandstones of the upper chalk, seem specially suitable for landslides. Two rows of stakes have been driven in so that measurements can be made to follow the movement.

WE learn that arrangements have been made by which Automatic and Electric Furnaces, Ltd., 17 Victoria Street, London, S.W.1, and Electric Furnace Company, Ltd., Elecfurn Works, 173-175 Farringdon Road, London, E.C.1, will jointly design Wild-Barfield internally heated electric furnaces having an input greater than 25 kw., which in future will be supplied by the latter firm. Automatic and Electric Furnaces, Ltd., will continue the manufacture and sale of the Wild-Barfield automatic hardening furnaces with magnetic detector, and internally heated type of furnaces up to 25 kw. Arrangements have also been made with George J. Hagan Co., of Pittsburg, U.S.A., who have constructed a large number of electric resistance furnaces up to 350 kw. capacity, for the use of their drawings and information, so that the best British and American practice will be incorporated in the designs.

Our Astronomical Column.

SOLAR SPECTROGRAPH FOR THE POULKOVO OBSERVATORY.—*Engineering* for July 18 contains a detailed description and several photographs of the 7-metre solar spectrograph by Grubb, which has just been erected at the Poulkovo Observatory. The instrument, in which a grating is employed, is of the Littrow type, and is modelled on the 30 ft. tower spectrograph at Mount Wilson. The sun's rays are received on a cœlostat, for which a special erection is made at the top of the south wall of the Observatory, and are reflected into an object-glass, after passing through which they are reflected to the slit of the spectrograph on the ground floor, where they form an image of the sun about 10 cm. in diameter. The main object of the instrument is the study of the sun's rotation by means of the Doppler effect shown by light from the eastern and western limbs. By using a system of four prisms, light from the centre and limbs of the sun is made to fall simultaneously on different parts of the slit, and the spectra are obtained in juxtaposition on a plate 24 cm. long by 4 cm. wide. The spectrograph lens has an aperture of 10 cm. and a focal length of 706 cm. No description of the grating is given, but it is stated that the instrument will give from one spectrogram a velocity measurement of greater accuracy than 1/10th of a kilometre per second in the line of sight. Arrangements are provided for rotating the instrument, the solar image remaining fixed. The cœlostat, which has an aperture of 25 cm., has been made adjustable for any latitude between 60° and 37°, in order that it may be used at the Simeis Observatory, in the Crimea, if desired.

THE LIVERPOOL ASTRONOMICAL SOCIETY, ANNUAL REPORT, 1923–24.—This body has undergone remarkable vicissitudes. It was founded in 1881 by Espin, Isaac Roberts, and R. C. Johnson, and proved so useful in helping beginners, and amateurs generally, that in a few years its membership rose to nearly 1000. Then a period of stagnation set in, and the publication of its journal became very irregular. It was the realisation of its earlier usefulness that led to the formation of the British Astronomical Association in 1890. The competition thus afforded led to a distinct revival of the Liverpool body, though it has since been a local rather than a national body. War difficulties once more led to a suspension, but all will be glad to hear that meetings have now been resumed and that the outlook is hopeful. Papers were read during the session by the president (Dr. Whichello); by Mr. W. Porthouse on the moon; Mr. J. Rice on relativity; Rev. A. L. Cortie, S.J., on sun-spots and magnetism; and others.

While not at all endorsing the president's statement that the B.A.A. is too much under the influence of the professional astronomer to be of use to the ordinary amateur worker, we may freely admit that it is a great benefit to astronomers at a distance from London to have their own meetings both for discussion and observation; and doubtless all will join in wishing this society, the name of which recalls happy memories to many of us, a new lease of useful life.

ANNUAIRE DE L'OBSERVATOIRE ROYAL DE BELGIQUE, 1925.—This useful annual contains the usual almanac information about sun, moon, planets, stars, tides, etc. It gives very full information about wireless time-signals, and time determination. Incidentally it notes that while most of the national ephemerides adopt the new system of commencing the astronomical day at midnight at the beginning of 1925, the Berliner Jahrbuch adheres to the old system. It will therefore be necessary to state the system employed fully and clearly in all astronomical time determinations: it will be unwise to use the phrase Greenwich Mean Time for the new system without some distinguishing mark: Greenwich Civil Time is probably the best to use, but a warning is necessary that it does not mean Summer Time.

An error may be noted in the table of Periodic Comets on p. 168. The period given for Tuttle's Comet, 12·15 years, is far too short. The next return should be given as May 1926, not February 1937. Also the Comet Grigg-Skjellerup should be included as due to return in 1927.

Research Items.

SHORT CIST BURIAL IN KINCARDINESHIRE.—A short stone cist unearthed at Catterline, Kincardineshire, in March 1923, contained a fairly perfect male human skeleton which has been carefully examined by Prof. R. W. Reid and recorded by him and Rev. J. R. Fraser (Proc. Soc. Antiq. Scot., ser 5, vol. x., 1923-24, pp. 27-40). The discovery revealed several unusual features. The covering of the cist, instead of being formed of a single series of large stones as is usual, was made up of several layers definitely arranged and graded, and embedded in sand three feet deep from top of bottom. One of the larger of the cover stones bore rude incisions in spiral and concentric circle form, but the weathering of the stone showed these were clearly handiwork of a much older date, and were not used as the artist had intended. Another of the cover stones was artificially perforated. The skeleton showed the ordinary characteristics of the round-headed bronze age race of north-eastern Scotland, with strongly platymeric limbs, but the skull capacity was unusually large, 1600 c.c., as against an average of 1458 c.c. for a considerable series of short cist skulls from the same region. The height of the individual was also out of the ordinary for his race, his stature, calculated from the leg bones, being 5 feet 10 inches, and calculated from the arm bones, 5 feet 8 or 9 inches. It would appear, however, that his arms were shorter in proportion to his legs than is the case in modern races. The average height of the short cist men of Aberdeenshire is only 5 feet 4 inches. The skeleton was accompanied by a low-rimmed clay beaker of the "drinking-cup" type, and by a fragmentary and rudely chipped quartzite pebble.

BIOCHEMISTRY IN INDIAN AGRICULTURE.—The Journal of the Indian Institute of Science, vol. vii. parts ii. and iii., contains two papers dealing with problems of considerable interest in connexion with Indian agriculture. In the first, G. J. Fowler and Y. N. Kotwal show, by a series of laboratory experiments, that dilute aqueous solutions of ammonium nitrite are not decomposed by other substances such as acids, amino-compounds, or hydrogen sulphide, which are likely to occur with them in ordinary agricultural or sewage disposal practice. Such loss of nitrogen as occurs in these operations cannot, therefore, be due, to any noticeable extent, to purely chemical reactions, but must be mainly the result of biochemical changes, as has indeed been generally assumed. The second paper deals with the retting of coconut husk for the production of coir. Coir is the fibre used in the production of coconut matting, and is therefore the basis of a large industry. So far as scientific investigation is concerned, it has been even more neglected than most of the coarse textile fibres, and Messrs. G. J. Fowler and F. Marsden are breaking new ground in tackling the problem. The fibre is obtained by soaking in water, which is changed from time to time for about ten months, the crude mass of fibrous tissue (mesocarp) which forms the husk of the fruit of the coconut palm. The natives who carry on this part of the industry have a good deal of rather indefinite and sometimes contradictory information as to the influence of various factors, such as the degree of ripeness of the fruit, the use of much or little water, the character of the water, and especially its salinity, on the quality of the fibre produced. Messrs. Fowler and Marsden find that the essential feature of the soaking process is the breaking down by bacterial agency of the material, described as insoluble gum or possibly a hemicellulose, which binds the fibre together in the husk. The necessary bacteria occur in the husk itself, and they remain active so long as the water is changed frequently enough to prevent them being poisoned by the products of the reactions they cause. The discoloration of the coir which sometimes occurs is due to changes in the tannin originally present in the husk, and the tannin, under unsatisfactory conditions of soaking, may oxidise to red insoluble products, which are deposited on the fibre, or if ferruginous water gains admittance to the soaking areas, may form iron tannate, producing "blue" fibre.

A NEW CERCARIA FROM NORTHERN INDIA.—Dr. B. Soparkar describes (*Indian Journ. Med. Res*, vol. xi., 1924) a new cercaria from northern India which presents several unusual features The tail is forked distally, and bears proximally two arm-like lateral processes each terminating in an oval structure which appears to be glandular and to serve as an organ of adhesion. The reproductive organs are much more developed than is usual—the ovary and two lobulated testes being clearly marked, and numerous motile spermatozoa could be seen in the vesicula seminalis. The entire length of the main excretory canal is ciliated. This cercaria develops in rediæ in *Melanoides tuberculatus*, but its further history after issuing from the snail is unknown. The cercaria has not been observed to encyst and it does not possess cystogenous glands; as it is not adapted for active penetration, the author suggests it is swallowed by the next host.

INTERACTIONS OF PROTOPLASMIC MASSES IN *ARCELLA POLYPORA*.—Bruce D. Reynolds (*Biol. Bull.*, vol. 46, Feb. 1924) finds that, like Difflugia, Arcella will, in favourable circumstances, reappropriate by fusion fragments of protoplasm which have been detached from it. Arcella is not attracted by a pseudopodial fragment of Difflugia, and if accidental contact is made the fragment is treated as a mechanical obstruction. Fusion will take place between one individual of Arcella and a protoplasmic fragment of a closely related specimen. Two distantly related individuals which have not been kept in the same receptacle will be attracted by each other's severed pseudopodia, but upon making contact the protoplasm involved will be shattered into bead-like masses. When two lines of a clone (a pure line) are kept under similar environments, cross-fusions between them cease after about 22 days, but if the two diverging lines are kept under different environments, cross-fusions cease after a shorter time—6 to 16·5 days. When small quantities of culture media are frequently interchanged between the hollowed slides in which the members of two diverging lines are kept, cross-fusions apparently continue indefinitely. When two related specimens have become negative to each other's protoplasm, cross-fusions between their progeny may be induced by exchanging small quantities of culture media or by placing them in the same culture medium (time required, 6 days). Physiological changes occur among the descendants of a single Arcella reproducing vegetatively, but such differences are probably due to environmental influences rather than to hereditary variations.

EXPLOSIONS AND ZONES OF SILENCE.—According to M. L. Gazaud's observations of the explosions at La Courtine on May 15, 23, and 25 made near Marseilles, the zone of direct audition is very limited in extent (*Comptes rendus*, Paris Acad. of Sci., July 28).

The explosions were in each case inaudible at the times calculated from the distance, and the same was true at Montpellier. The explosion of May 15, however, was distinctly registered at both stations, but with retardations corresponding to extra paths of 90 and 135 km. respectively, the distance in a straight line from La Courtine being 360 km. At the same time a thick mass of cumulus cloud was observed, rising above the mountain masses of Ventoux and the Basses Alpes, forming an obstacle which was evidently quite capable of reflecting sound waves coming from La Courtine Such a wall of cloud, if it were concave in front, could concentrate the sound waves so as to make them audible at certain points. A simple calculation of the probable trajectories for the two stations confirmed the above hypothesis, and fixed the probable points at the edge of the cloud mass where the sound was reflected. Reflection from above is shown to have been impossible in these cases, as at the height required to give such large differences of path, the pressure of the air would be very small, and very little sound would be transmitted.

NATURAL GAS INDUSTRY.—Three advance chapters of the Mineral Resources of the United States, volume for 1922, dealing with Natural Gas, Natural Gas Gasoline and Carbon Black produced from Natural Gas, contain significant data proving the rapid development of this industry in America. Consumption of natural gas in 1922 amounted in the United States to 762,546,000,000 cubic feet, being 15 per cent. more than the quantity used in the previous year. West Virginia, Oklahoma, and Pennsylvania ranked chief among the twenty-three producing States, each giving over 100,000,000,000 cubic feet, showing that the palæozoic compared with the tertiary fields are still the most important from the point of view of gas production. The unit value of the gas has also gradually increased, the average at points of consumption being 29·1 cents per 1000 cubic feet compared with 21·6 cents in 1919; the value in domestic consumption shows proportionate increase, being 49·9 cents per 1000 cubic feet in 1922. Unblended gasoline extracted from natural gas in the year under review amounted to 505,832,000 gallons, representing a 12 per cent. increase over the previous year and 8 per cent. of the total gasoline produced in America from all sources. The average yield of gasoline per 1000 cubic feet of gas thus works out at 0·9 gallon. Of the 917 plants in operation for the extraction of this product throughout the United States, those of the compression type produced by far the largest amount of gasoline, though statistics show that the combination process is steadily increasing in favour. The average value per gallon of natural gas gasoline was 14·4 cents in 1922. Carbon black manufacture likewise showed an increase of 13 per cent. over the previous year, amounting in 1922 to 67,795,000 pounds; the advance was largely due to the greater demand for this commodity in the rubber tyre industry. Louisiana and West Virginia together were responsible for more than 90 per cent. of the entire output of the country, the Monroe field of the former State contributing in no small measure to this result. The average price per pound of carbon black was maintained at 8·6 cents, a slight decrease compared with 1921.

ACOUSTICS OF HALLS.—Owing to the pioneer investigations of the late Prof. Sabine, the factors which determine the acoustical properties of rooms are becoming known, and the provisional theory is being tested by the observations made in halls of various sizes and shapes by auditors whose opinions are of value. As the result of a considerable amount of work of this kind, Prof. F. R. Watson, of the University of Illinois, suggests in the July issue of the Journal of the Franklin Institute an improvement in the law expressing the best time of reverberation in a hall in terms of its volume. His expression for a hall without audience is, time in seconds $=0{\cdot}75+0{\cdot}375\sqrt[3]{\text{volume}}$, the volume being in cubic feet. He concludes also that in increasing the absorbing material as the hall gets larger, it is best to keep the average absorption per unit area constant. This involves the energy of the sound source being proportional to the area of the surface of the hall.

THE QUANTUM THEORY OF RADIOACTIVE DISINTEGRATION.—In an article in the *Zeitschrift für Physik* of August 4, Dr. A. Smekal shows that the quantum mechanism proposed by him in 1922 gives a complete explanation, on the lines of the Bohr theory, of all the β-ray spectra which have so far been determined with certainty. Rosseland's criticism of this mechanism is ungrounded, and it is shown that he has simply applied the views of the author to explain the continuous β-ray spectrum of a very special class of β-ray disintegrations. The close analogy between X-ray and β-ray spectra supplies an explanation of the relationships found by Ellis and Skinner between the sequence of the nuclear levels in radium B and radium C. Wentzel has shown that "spark" lines are found in the X-ray spectrum, due to multiple ionisation, the terms of which bear a definite relationship to those of the normal lines. In a β-radioactive atom, instead of a recombination of an electron, as for X-rays, an electron is given off from the nucleus, or moved to an outer orbit. If two β-radiators follow one another in the periodic system, there is a close analogy with the case of a non-radioactive atom which has lost both its K electrons, and in regaining them will give spark lines, as well as the normal X-ray spectrum.

X-RAY ABSORPTION SPECTRA.—New measurements have been made of the fine structure of the K absorption band head of Ti, V, Cr, and Mn, and of the L_{III} band head of Sn, Sb, Te, and I, by Dr. D. Coster, *Zeitschrift fur Physik*, July 2, and it is shown that the character of the structure depends on the chemical state of the element concerned. When the valency of the element in the compound used is high, an absorption line, Ka, $L_{III}a$, is found on the long wavelength (soft) side of the band head, but not for compounds in which the element has a low valency. It is thought that the principal band head corresponds to the sudden rise, from zero to a maximum value, of the probability for the removal of an electron from the layer concerned to infinity, when the wave-length diminishes to a particular value; the lines Ka and $L_{III}a$ are probably due to the removal of the electron to an inner electronic layer. The principal band head approaches the position of the Ka or $L_{III}a$ line as the chemical state of the element approaches that of the uncombined gaseous element. It may very well be that the lines Ka and $L_{III}a$ really exist in all cases, but can only be observed when the separation from the principal band head is sufficient. The author deals with the theory of this shifting of the band head and with that of the maxima and minima of absorption observed on the "hard" side of the band head. It is suggested that, in this region of the spectrum, besides the "photo" effect, there is another possibility, so that the atom may take up a larger energy quantum than that corresponding to the removal of an inner electron to infinity; the extra energy might be used in removing an electron simultaneously from

the outer layer; or the atom or atomic complex may be in some special state of tension after the absorption.

FIRST LAW OF PHOTOCHEMISTRY.—The Journal of the Chemical Society for July contains an important paper by Mrs. M. C. C. Chapman on the first law of photochemistry. This law, which was enunciated by Draper in 1843, states that the amount of chemical change in a given system effected by light of a specified wave-length is proportional to the light absorbed. Although this is a fundamental principle of great importance, its validity has not been conclusively established. Its accuracy has, in fact, recently been challenged by Baly and Barker, who found that in the case of the combination of hydrogen and chlorine, when the light intensity was increased in the ratio of 1 : 6, the rate of combination increased in the ratio of 1 : 10. Mrs. Chapman has carried out careful experiments with the same reaction, and the results show that the rate of combination appears, if anything, to increase with the light intensity rather less rapidly than is required by Draper's law. For the ratio of intensities 1 : 6, the ratio of rates of combination was 5·49 in one group of experiments and 5·67 in another. With six slits, the ratio of rates of combination occasioned by opening six slits compared with that with two slits was 1 : 2·97, 1 : 2·95, and 1 : 2·97. The deviation from Draper's law is ascribed to the temporary reduction in pressure of the water vapour occasioned by the formation of hydrogen chloride rather than to an inhibitive action of hydrogen chloride. The experiments were made in the presence of water. The conclusion reached is that the abnormal result obtained by Baly and Barker could not be substantiated, and that Draper's law is valid even in the case of the photochemical change which exhibits the greatest departure from Einstein's law of photochemical equivalence.

BAKERY RESEARCH.—A report on research work carried out at the National Bakery School, London, has recently been issued by Dr. C. Dorée and Mr. John Kirkland. It is divided into four sections, namely, (1) variation in weight of loaves due to loss in baking, (2) weight conserving effects of wrapping loaves in waxed paper, (3) variableness of oven temperatures, (4) quicker ripening of hard flour doughs. With respect to the first part of the report, the opening paragraph quotes the Report of the Interdepartmental Committee on the Sale of Bread by Weight which stated that, in spite of the difficulties encountered, it is possible to estimate with reasonable accuracy the loss which takes place in baking and after. The sale of bread by weight places the baker in a very difficult position, as it has been suggested that it is by no means easy to tell how much dough should be scaled off so that the resultant cooled loaf should just be the desired weight. No conclusions are directly drawn contradictory to the committee's considered opinion, but the mass of carefully collected data in this report throws very grave doubts on its correctness. Loss of weight is found to be affected by the tightness of the dough, by the position in the oven, by the kind and shape of the loaf in question, by the degree of ripeness of the dough, by the length of time the bread is in the oven, and by the presence or absence of certain moisture pastes chiefly of a starchy character. It is further shown that attention to these points is a matter of considerable financial importance to the practical baker. The second part of the report dealing with the effect of wrapping on the weight of the loaf is very limited in scope, although the results are of interest. It is shown that the expense of wrapping is partly met by the decreased loss in weight of the loaf on keeping. There was unfortunately no work done on the important question of the increased cleanliness of the loaf. As to the variableness of oven temperature, it appears that there is often a range of temperature in different parts of the oven of 50° F., and in some cases of more than 100° F. It may be that some of the rather inconsistent results reported in the first part of this report are due to this varying factor. The final part deals with the quicker ripening of certain hard and strong doughs. In view of modern labour conditions it is necessary that something should be done to the stronger and slower ripening flours if they are to be ready for the oven quickly, and the practical suggestion of the addition of lactic acid and the preparation of pastes rich in lactic acids is made.

COAST DEFENCE WORKS.—The destructive effect of the grinding action of shingle or boulders on concrete structures erected on the foreshore is well known. Dr. John S. Owens describes a method which has been used successfully on the south coast of England, and illustrates it with photographs in the *Engineer* for August 8. The method consists in facing the concrete sea wall with wood blocks set in cement, with the end grain exposed. One of the photographs shows an experimental patch of wood blocks inserted in 1921, and the wear of the unprotected surrounding concrete has been from 1½ in. to 2 in. more than the wood. The wood blocks indeed show but little signs of wear, and it has been noticed that where a knot came to the surface of the wood there was a definite hollow worn, the hard knot being worn more rapidly than the surrounding soft wood. The experiments were regarded as so promising that a considerable length of sea wall was faced this spring with wood blocks. The blocks are mostly 6 in. square on the surface and are set with headers 9 in. long at intervals, the other blocks being 6 in. deep. All the blocks were set in neat cement grout and were held in position in the first instance by double-pointed nails, as one of the difficulties encountered was to keep them in correct position while the concrete behind was filled in and rammed.

LATERALLY LOADED STRUTS.—Technologic Paper No. 258 of the U.S. Bureau of Standards contains an account of some tests on steel tubing made by Mr. Tom W. Greene with the view of ascertaining whether experimental results confirmed the theory of laterally loaded struts. The range covered the cases of a column without transverse load to that of a beam with no column load. It was found that the eccentricity due to variation in wall thickness and to deviation from straightness is an important factor. A modified rational formula based upon consideration of the effect of eccentricity was found to fit the experimental results very closely. Failure of a strut will occur when the maximum compressive stress computed by the modified formula is approximately equal to the yield point, and the modified rational formula reduces to the "secant" column formula when the transverse load is equated to zero. A reasonably accurate computation of the stress in a laterally loaded strut can be made by summing the bending stress due to the transverse load and the column stress obtained by the "secant" formula, provided that in the latter formula the effective eccentricity is taken as the sum of the original eccentricity (due to tube irregularities) and the deflexion of the strut at the centre resulting from the transverse load. The methods of measuring the eccentricities in the test struts are clearly described in the paper, and, judging from the exactness of agreement shown by the checks applied, appear to be very accurate.

The International Commission on Illumination.

THE second technical session of the International Commission on Illumination was held in Geneva on July 21-25, under the presidency of Dr. E. P. Hyde (U.S.A.). About forty delegates from France, Great Britain, Italy, Switzerland, and the United States of America were present, while observers from Japan and Poland attended the meetings. The delegates were welcomed to Geneva by M. Stoessel, president of the city, while Dr. Carrozzi, representing the health section of the International Labour Office, welcomed the collaboration of the Commission in problems which were of particular interest to his section. The president announced that national committees were in the process of formation in Belgium and also in the Union of South Africa.

At the first technical meeting two papers dealing with primary standards of light were presented by Dr. Crittenden (U.S.A.), on behalf of Dr. Ives, and by M. Fleury (France). Dr. Ives, by using a cylindrical platinum black body at the instant of melting, has obtained results which are considered sufficiently reproducible to make this type of black body a suitable primary standard. His results indicate that at the melting-point of platinum the black body has a brightness of 55·4 candles per square centimetre, and its radiation very closely colour-matches that of the carbon filament lamps operated at 4 watts per mean horizontal candle, in which the international candle is maintained. M. Fleury is using a carbon tube furnace held at such a temperature that the intensity of the radiation between two given wavelengths is N times that between the same wavelengths emitted by a black body held at the melting-point of gold. The power consumed in the furnace, and hence its temperature, is maintained constant by the use of a thermionic valve controlling a generator, and it is anticipated that the constancy of temperature will be sufficiently exact to enable the furnace to be used as a primary standard of light. As a result of discussion the Commission passed a resolution recommending that the brightness of the black body operated under definite specified conditions be adopted as the primary standard of light, and that the various National Laboratories be asked to specify conditions and to determine its value in terms of the international candle at present in use. An exceedingly comprehensive paper dealing with the properties of tungsten and the characteristics of tungsten lamps was presented by Dr. Crittenden (U.S.A.) on behalf of Dr. Forsythe and Dr. Worthing. Other papers were concerned with the description of an acetylene standard lamp for use in sensitometry, and of special holders for electric lamps used as photometric sub-standards.

The second technical meeting was taken up with the study of problems in connexion with photometric definitions and symbols arising out of the report of the international committee on definitions and symbols, presented by M. Fabry (France) on behalf of M. Blondel, and the reports of the various national committees. A technical sub-committee was appointed to deal with the recommendations, and agreement was reached on about fourteen definitions, in addition to those on which agreement was reached at the Paris meeting in 1921. Definitions were finally adopted of transmission, absorption and reflection factors, brightness, visibility, total flux, mean spherical intensity, reduction factor, efficiency of a source, and several other quantities. Symbols for luminous flux, luminous intensity, illumination, and for transmission, absorption, and reflection were also agreed upon.

The Italian National Committee presented a vocabulary of illumination in Italian, and it was agreed that it would be advantageous if there were corresponding vocabularies in English, French, and German. As the Swiss National Committee had already placed on its programme the collation of the Italian and French vocabularies, it was decided that this work should be extended by including English and German, and it was decided that a sub-committee with a Swiss chairman should be appointed to deal with the matter.

The third technical meeting opened with a paper by Prof. Fabry (France), chairman of the sub-committee on heterochromatic photometry, appointed at the Paris meeting. Prof. Fabry gave an excellent account of the work done since the Paris meeting on the subject of heterochromatic photometry, and of a programme of work which, if carried out by the sub-committee, would be of the greatest value. A paper was presented by Mr. H. Buckley (Great Britain) on behalf of Messrs. Buckley, Collier, and Brookes on the colour temperature scale for tungsten. Very satisfactory agreement with existing data was obtained in this preliminary work, which it is intended to repeat to greater accuracy. M. Jouaust (France) read an interesting paper on the use of absorbing screens in heterochromatic photometry. Dr. Crittenden (U.S.A.) presented a report on behalf of Mr. K. S. Gibson on the relative visibility function. This report reviewed the more recent work on this problem, including that by Messrs. Gibson and Tyndall, in which the step by step method of direct comparison of different portions of the spectrum was used. It appears from this work that, contrary to what had been suspected, the direct comparison method gives the same results as those obtained by methods involving flicker photometry. The Commission passed a resolution that the values recommended by Mr. Gibson should be adopted as provisional standard values of the visibility factor, except in certain specified cases such as arise in considering the ends of the spectrum or in particular conditions of field intensity and size. These new values differ only slightly from those recommended at the Paris meeting in 1921. The Commission decided at this meeting that the sub-committee on heterochromatic photometry should extend its activities to include the investigation of the transmission characteristics and the specification of coloured glasses, particularly of those glasses used in photometric measurements. It was also decided that a new committee consisting of three members should be set up to deal with colorimetry.

The fourth technical meeting dealt with street lighting and with certain aspects of illumination engineering practice. Mr. H. T. Harrison (Great Britain) presented a paper in which he developed the idea that street lighting should be more of the projection type, such as is associated with automobile headlights. Papers were also presented on street lighting in Paris by gas and electricity, and on some interesting traffic regulating signs recently installed in Paris. A proposal was made that the Commission should recommend the fixing of a legal minimum of illumination for street lighting. It was decided, however, that though it might be desirable for the Commission to give the weight of its opinion on street lighting, this was such a debatable subject that action had better be deferred pending further consideration, and it was agreed that at the next meeting the question of street lighting should be given greater prominence.

The papers on illumination engineering practice were the first of their kind which had been given before the Commission. In these, the authors, Messrs. Lieb, Merrill, and Powell (U.S.A.), gave an account of some of the features of the organised campaign which is being carried on in America to promote the wide-spread practical application of the principles of good lighting. Dr. Lieb urged that the work of the Commission should not be restricted merely to the theoretical aspects of illumination, but should be extended to include the practical aspects of illumination engineering so that it would be of benefit both to manufacturers and the general public. Mr. Merrill described the method of conducting good lighting demonstrations, while Mr. Powell described various types of propaganda work, and surveyed a large field of investigatory work in practical illumination engineering.

The fifth technical meeting dealt with factory and school lighting and with automobile headlights. Mr. L. B. Marks (U.S.A.) presented the report of the international sub-committee on lighting in factories and schools as a basis of international agreement. Recommendations of the minimum illumination in various circumstances, of the maximum brightness of light sources, of exit and emergency lighting, and of the colour and finish of school interiors, were made. There was general agreement that at present standard minimum values of illumination for working conditions should not have any legal force, and that whatever regulations are made should be based solely on considerations of the health and safety of employees. Mr. Gaster (Great Britain) presented a paper on some further developments in industrial lighting in England, and M. Bordoni (Italy) on some phenomena of glare. Dr. Sharp (U.S.A.), chairman of the international sub-committee on automobile headlights, presented a report in which the proposals made by each of the various countries were reviewed, while papers dealing with the photometry of automobile headlights were presented by Messrs. Bossu and Cellerier (France).

After the technical meetings were over a plenary meeting of the Commission re-elected Dr. E. P. Hyde to the office of president for the next three years. Mr. C. C. Paterson was also re-elected to the office of honorary secretary and treasurer, and Messrs. Edgcumbe (Great Britain), Rouland (France), and Semenza (Italy) as vice-presidents, while Mr. Walsh of the National Physical Laboratory, to whose ability and efforts the technical success of the meeting was so largely due, will continue his work as general secretary for the next three years. It was provisionally decided that the next meeting should take place in the United States of America in 1927.

The meetings were held in the Palais Eynard, which was kindly placed at the disposal of the Commission by the City of Geneva. The delegates were entertained at a motor excursion and a dinner at Bellerive on the evening of Tuesday, July 22, by the president and members of the Geneva City Council; and at a dinner at the Hotel des Bergues by the Swiss National Committee on Wednesday, July 23. On July 24 the Swiss National Committee were the guests of the foreign delegates at a dinner held at the Parc des Eaux Vives.

The Swiss National Committee, particularly the president, M. Filliol, and the secretary, M. Largiardèr, were responsible for the excellent arrangements made for the meeting, while M. Thomas, the director of the International Labour Office, very kindly placed a secretarial staff and interpreters at the disposal of the Commission. H. B.

The Automatic Measurement of Atmospheric Pollution.[1]

By Dr. J. S. OWENS.

THE suspended impurity in the air can be measured by two methods, the automatic recorder or filter, and the jet dust counter method. The former was designed primarily for measurement of smoke pollution, and depends upon filtration of the air through white filter paper, the resulting discoloured spot being compared with a calibrated scale of shades. In the dust counter method the results are independent of the colour of the particles, a count of their number as well as an examination of their size, shape, and nature being made microscopically. Curves showing the numerical value of the suspended impurity for different cities and its variation from hour to hour can be plotted from the average figures for a large number of days. The cities selected for this purpose were London, Rochdale, Blackburn, Glasgow, and Stoke-on-Trent.

The London curves of impurity for Westminster, Savoy Hill, and Kew Observatory indicate that the impurity is lowest between midnight and 6 A.M., after which it rises rapidly to a maximum between 9 and 10 A.M., falling again steadily until about 4 in the afternoon, when there is a tendency to rise slightly to a second but lower maximum. At about 10 P.M. the impurity falls away until about midnight. The Sunday curves are similar, but the maximum in the forenoon is not reached until about an hour later. The rise of impurity between 6 and 7 A.M. is attributed to the lighting of fires, the smoke from which is emitted in greatest quantity soon after lighting.

In plotting the curves referred to, it was found advisable to divide the days into two groups:

(a) Days in which there was much smoke haze at some time, as indicated by the automatic recorder showing a shade number equal to or above 4—equivalent to 1·28 mg. per cubic metre. These were referred to as "Z" days.

(b) Days of little smoke haze when the maximum did not reach Shade 4.

As the existence of thick smoke haze over a city on certain days is due rather to failure of the natural processes by which normal smoke is removed as produced, than to abnormal smoke production on those days, this division is an attempt to separate ordinary days from those in which the ventilation fails, usually during anti-cyclones with light or indefinite winds and inversion of the lapse rate.

The distribution of impurity for Rochdale and Glasgow is very similar to that in London. The records from Blackburn exhibit certain peculiarities. These were prepared from an average of 269 days for the year 1923–24, 136 being winter—72 of which ranked as "Z" days, that is, days of much smoke haze.

The hourly distribution in Blackburn has certain important peculiarities; for example, a rapid rise of impurity commences in the morning in the summer about 4 A.M., and reaches its maximum on week-days and Saturdays at 7 A.M., while on Sundays the maximum is not reached until 10 A.M. Again, in the week-day and Saturday curves there is a second maximum between 10 and 12 in the forenoon, higher than the first, and separated from it by a 4-hour interval.

It is inferred from this that there are two main sources of smoke, making their maxima at different

[1] Substance of a paper read before Section A (Mathematics and Physics) at the Toronto meeting of the British Association.

times. The Sunday curves show no evidence of a double maximum in the forenoon. It is therefore inferred that the first maximum is due to industrial and the second to domestic smoke. In support of this is the fact that in winter the second maximum is higher than the first for week-days, while in summer the first is higher than the second. The relation between the total smoke emitted on Sundays and on week-days is as 2000 to 3077, based on the curves for ordinary winter days—not ranking as "Z" days. If the Sunday smoke be assumed to be domestic, and the week-day smoke domestic plus factory, the ratio of factory to domestic smoke becomes 1 : 1·85.

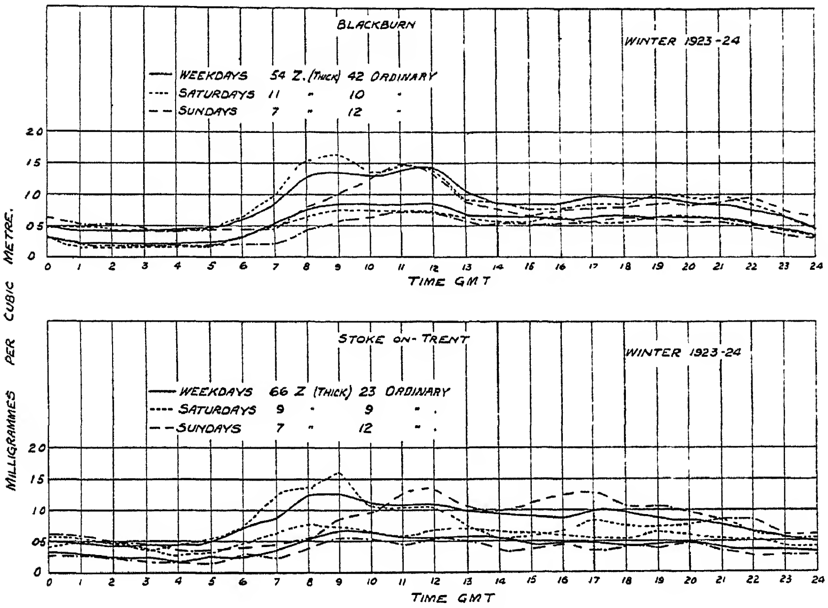


FIG. 1.—Suspended impurity in the air.

Stoke-on-Trent exhibits even more peculiarities than Blackburn. Stoke is a pottery city containing about 2500 ovens. Records are available for a total of 222 days, including 126 winter days —82 of which ranked as "Z." Thus of the winter days recorded 65 per cent. had thick smoke haze, that is, on two out of every three days.

Fig. 1 shows that a definite rise began about 4 A.M. on week-days and 5 A.M. on Sundays. On summer week-days and Saturdays the maximum is reached between 7 and 8 A.M., while in the winter on week-days and Saturdays the maximum is between 8 and 9 A.M., and on Sundays about mid-day. In both summer and winter the impurity is maintained at a high level during the whole afternoon, but with remarkable oscillations, not shown in the records of the other cities mentioned. The minimum impurity is found at about 3 A.M.

The amount of suspended impurity in Stoke on ordinary winter Sundays is not much less than on week-days, the ratio being as 2022 to 2398. Here there are evidently conditions which make it impossible to apply the method already used for ascertaining the relation of factory to domestic smoke. In all the Stoke records for summer and winter, the Saturday maximum in the forenoon is the highest. This can be traced to the custom of lighting pottery ovens on Friday night or Saturday morning.

The incidence of atmospheric impurities on different days of the week has also been examined for six different cities, from which it appears that there is a general tendency to a minimum of smoke haze towards the end of the week, and a maximum about the beginning.

Since the records of the automatic instrument upon which the above conclusions were based depend upon the discoloration of a filter paper by the trapped impurity, experiments were made in which the results obtained with the dust counter method referred to were compared with those by the automatic recorder. In the latter, which was intended for recording city smoke, the impurity is assumed to be black, whereas the dust counter is independent of colour.

In the latter, fully described elsewhere,[2] the action depends upon the projection of a narrow ribbon-shaped jet of air against a microscope cover glass at such a velocity that a marked fall of pressure occurs with adiabatic expansion and cooling of the jet and consequent condensation of water, supplied from a damping chamber, upon the dust particles and the cover glass where the jet impinges. This results in the dust particles being projected against the cover glass by virtue of their greater density, and their increase of mass due to the condensed water. They adhere to the glass as the water evaporates, leaving a linear trace of dust, which can be examined microscopically and counted.

Simultaneous observations were taken with both instruments, and the results plotted in Fig. 2. From this curve it is evident that there is a reasonably constant relation between the number of particles per cubic centimetre, and the weight of impurity in milligrammes per cubic metre as given by the automatic recorder.

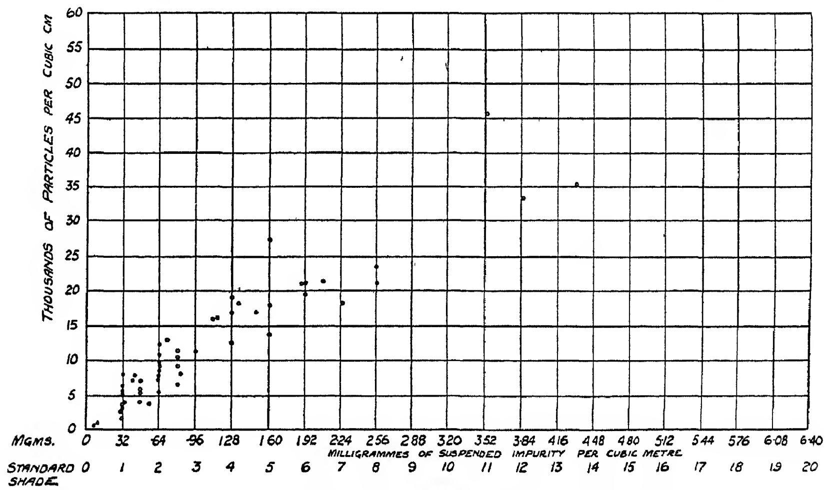


FIG. 2.—Comparison of automatic filter and jet dust counter records.

This indicates a tendency towards uniformity in size of the particles at different times, but there is also a definite departure from such uniformity during thick smoke haze when the average size increases, doubtless due to insufficient time for separation by

[2] Proc. Roy. Soc. A, vol. 101, 1922.

settlement. The maximum diameter of smoke particles in the absence of thick smoke haze is about $1\frac{1}{2}$ microns, while during thick smoke haze the maximum reaches about 3 microns. Fig. 2 shows that the relation in London between number and weight of particles is usually such that 10,000 particles per c.c. corresponds to 1 mg. per cubic metre. It is not suggested that this relation holds good for all types of dust, but it shows that the automatic recorder gives trustworthy comparative results for city air, where the colour of the suspended particles is usually black.

Horticultural Research.

THE growing recognition of the importance of research work in connexion with the fruit industry is emphasised by the Annual Report issued by the National Fruit and Cider Institute at Long Ashton, Bristol. The year 1923 was the first since the outbreak of the War in which the work could be conducted under relatively settled and stable conditions, and it was marked by steady progress as regards both advisory and research work. The direct and practical bearing of the research work upon the current problems of fruit growers is very noticeable, and though many of the results are still preliminary or tentative, they open up suggestive lines for future progress.

The manurial experiments on fruit trees in pot cultures have been continued to study the effect upon growth of the omission of the various essential elements in turn. Leaf scorch affected many of the plants, but an increase in the amount of potash entirely prevented the development of scorch, while a reduction of nitrogen retarded it and reduced its amount. An examination of the root systems of various fruit trees shows that under many systems of planting there must be considerable overlapping of roots, introducing a serious element of competition which probably acts as a severe check to growth in many cases. This research is being continued in connexion with the danger of planting up orchards of large trees with soft fruit, if the latter is left too long on the ground. In connexion with the damage wrought by the apple blossom weevil it is pointed out that isolated efforts of control are unlikely to be efficacious, but that co-operative action is essential for success. Direct control methods must be associated with hygienic conditions in the fruit plantation, and a scheme of procedure is outlined, embracing a sequence of scraping, spraying, and banding the trunks, followed by the collection of capped blossoms in May. Other pathological investigations deal with egg-killing washes, the effect of sulphur on black currant mite, "red plant" in strawberries and its correlation with "cauliflower disease," purple leaf blotch of strawberry, and the infrequent disease of pear leaf blister.

A most interesting investigation is that of cold process fruit preserves. Under ordinary methods of preparation, jams, jellies, and fruit juices are subject to prolonged high temperature, to the detriment of their flavour, colour, and aroma. With the "cold" method the consistency of the product must be such that micro-organisms do not develop, a condition that can be secured by increasing the sugar content to 62-65 per cent., or less if the acidity of the fruit is high. Jellies and fruit juices give very satisfactory results, but more difficulty is experienced with the jams. Large-scale trials are being made to determine whether these methods are suitable for development under commercial conditions.

Another aspect of the work is shown by experiments on the "buffing" of willows, a process whereby, after prolonged boiling in water, a mineral-brown colour is imparted to the wood of willow rods. Freshly cut willow rods can only be peeled for a short time in the spring, owing to the rapid production of new wood which interferes with satisfactory peeling. "Buffed" rods can be peeled throughout the year, and the introduction of the process has been of great importance to the growers and to the basket industry. Improved methods are being sought and possibilities of industrial application worked out.

The chief lines of work at the Fruit and Cider Institute have been touched on above, but various other researches are being carried out, some of which may lead to more extended inquiries in the future, and others are of importance in their relation to the main investigations.

Problems of Human Nutrition.

THE investigation of human nutrition dealt with in the report before us [1] was undertaken in the autumn of 1922 during a period of depression for those engaged in the coal mining industry. Details regarding the actual food consumption were obtained from 140 families distributed in five different counties. The general result of the inquiry shows that though the average consumption of food in Derbyshire was sufficient for a healthy life when judged by accepted standards, the average diets in Northumberland, Lancashire, Stirlingshire, and in particular Durham, were not so satisfactory. In the latter county the weight of the miners' children was slightly below the county average, though it seems probable that factors other than a deficient diet may have been partly responsible for this. The Committee is cautious in drawing conclusions, since the number of families investigated was not large, and it was recognised that the method adopted of reducing each family to the equivalent of "average men" for the purpose of assessing the nutritional value of the family diet is not free from objection.

The Committee has assumed that the average daily food requirement of a miner is equivalent to some 3400 calories. This figure has, however, not been ascertained by direct observation, but is inferred from a consideration of the numerous data already available on the energy output of man under different conditions of rest and work. Prof. K. N. Moss, in an investigation of the effects of high underground temperatures on the miner, has recently given details of the actual food consumption of a selected number of miners in different districts who had a high reputation for steadiness and industry. These figures show an average daily energy intake of well over 4000 calories, a value much in excess of that assumed by the Committee. Moss's selected subjects were clearly well above the general average, but if we regard the Committee's estimate as approximately true for this general average, it is apparent that there may be very great differences of energy expenditure between different individuals employed in the same industry. It is not alone the actual work done in the mine that matters, for much energy may be expended by the miner in walking to and from his work and in recreation in his spare time: as regards the last two items there is the possibility of great individual and local variations.

It is evident that further investigation is required regarding the actual energy output under everyday conditions not only of miners, but also of workmen in

[1] Medical Research Council. Reports of the Committee upon Quantitative Problems in Human Nutrition: Report on the Nutrition of Miners and their Families. Pp. 59. (London: H.M. Stationery Office, 1924.) 1s. 3d. net.

other industries involving heavy manual labour. So long as uncertainty prevails as to the true energy requirements of the individual, the assessment of the nutritional value of the family diet in the manner adopted by the Committee cannot acquire its full value. In times of financial stress the full diet of the wage-earner may have to be maintained at the expense of other members of his family, and the children may in the end be the real sufferers. It is to be hoped that the Report of the Committee is but the prelude to further investigations which will dispel the obscurity which still surrounds some of the important practical problems of human nutrition. The work is bound to be very arduous, but it is worth doing, for apart from its value to the physiologist it has a direct bearing on modern economic questions.

Haddock Biology.

MR. HAROLD THOMPSON has made a useful contribution to our knowledge of the life-history of the haddock in the report before us.[1] This fish is of increasing commercial value, and its abundance fluctuates considerably from year to year. By the researches which Mr. Thompson describes, he certainly brings nearer the time when the causes of these fluctuations will be better understood, and he foreshadows the possibility of being able to predict for two or three years ahead any special scarcity or abundance of the fish in a particular area such as the North Sea.

Great importance has been attached to the accurate determination of the age of the fish. For the haddock it has long been recognised that the most trustworthy determinations of age can be got by studying the markings on the scales. The author has, however, subjected the whole method of age determination in this fish by means of the scales to a minute and critical examination, and especially has been at great pains to study scales taken from many different parts of the body This careful but tedious examination has justified the methods employed, and the satisfactory conclusion has been reached, that if a few normally shaped scales be taken from a haddock, it is possible in about 95 per cent. of cases to read the age from the number of annual zones marked on them; and further, that by measuring these zones and comparing their length with the total length of the scale in each instance, one can calculate the sizes attained by the fish at the end of each previous year of its life.

The author considers that North Sea haddock grow on the average 17·5 cm in the first year, though the range of size is considerable, from 11 to 21 cm. The greatest growth in this, as in other years, takes place in the autumn, and growth practically ceases in November, when the scale has formed about 22 rings (sclerites). The first scales make their appearance when the fry are about 3 cm. long. In 1922 and 1921, yearling haddock were sparsely represented in the North Sea, but the 1920 brood was extremely abundant, as shown by the prolific numbers of one-year-old fish in 1921 and two-year-old fish in 1922, in the later months of which year they formed the mainstay of the Aberdeen market haddock supply. The year 1904 was a similar good brood year for haddock and was followed by an abundant fishery of three-year-old fish in 1907.

The rate of growth of the haddock varies in different regions. In the same latitude the best grown fish are found in shallower and warmer water, whereas there is a diminution in growth rate with increase of the depth from which they are captured. South Iceland and Faroe haddock exhibit faster growth than those captured in the North Sea and off the northern coasts of Scotland, for there favourable temperature conditions occur throughout the year, and the temperatures are so much less variable that it is often difficult to note the annual zones on the scales.

The paper is a valuable contribution to the literature of British fisheries.

[1] "Fishery Board for Scotland: Scientific Investigations, 1922. No. 5. Problems in Haddock Biology, with Special Reference to the Validity and Utilisation of the Scale Theory. 1: Preliminary Report" By Harold Thompson. Pp. ii+78+3 plates. (Edinburgh and London: H.M Stationery Office, 1923.) 7s. net.

The Iron Ores of China.

THE widespread distribution of local iron smelting in China led to the general belief that China possesses some of the greatest reserves of iron ore in the world. More careful investigation has failed to confirm some of the earlier estimates, and has led to the under-rating of the quantity of available Chinese iron ores. The series of Memoirs on the iron ores and iron industries of China, of which the first part by F. R. Tegengren has been issued by the Geological Survey of China,[1] will correct the wild statements that have been made on both sides. The first part deals mainly with the ores of the northern and eastern provinces, and is accompanied by 16 plates and a folio atlas including 39 maps. The first map, in which the names are conveniently given both in English and Chinese, shows the general distribution of the iron ores in eastern China. It does not mark those in far western China, where there are many primitive furnaces which smelt iron for their neighbourhood. Their supplies of ore are ample, but are too remote to be of service except locally at the present time

The Chinese iron ores are of three main types. The first type comprises the pre-Cambrian bedded ores, including the banded quartzitic ironstones that are widely spread in western Australia, India, and South Africa. Of the pre-Cambrian ores the most interesting geologically are the stromatolitic ironstones, of which one of the best known representatives are the Wabana ores of Newfoundland. The author discusses their origin and attributes them to chemical precipitation; he discourages the view of their organic origin, though on grounds which are not convincing; and he recognises that they may indicate the existence of pre-Cambrian life. The second group includes the contact ores which have been formed beside intrusive masses of granodiorite along the lower Yangtze; they include some of the most important and extensive iron ore deposits in China. The third group includes the nodular ironstones of the Palæozoic rocks and they are found especially in north central China. They have been largely mined for the local smelters, and exaggerated estimates have been often formed of their quantity. The author concludes that in most cases the nodules are in beds too thin and too scattered to be of value for working under present conditions on an extensive scale.

The text is issued in both English and Chinese. The volume and the maps are well printed and edited; misprints, such as are probably inevitable when a work by a Swedish author is issued in English and printed in China, are commendably few, though the reversal of the headings of phosphorus and silica in the table on p. 38 gives at first a startling aspect to the analyses. The subsequent parts of this important memoir will include a summary of the distribution of the iron ores of the circum-Pacific region. J. W. G.

[1] "The Iron Ores and Iron Industry of China, including a summary of the iron situation of the Circum-Pacific Region." By F. R Tegengren, Mem. Geol Surv. China, Ser. A, No 2, Pt I, 1921–23, 180 pp., 16 pls. Accompanied by Atlas of 39 maps. Also Chinese Text.

University and Educational Intelligence.

APPLICATIONS are invited for two professorships in the Latvian University at Riga, namely, astronomy and theoretical mechanics, and geology and palæontology, the duties of which will date from January 1 next. The appointments will be for five years only, as at the end of that period the lectures will be delivered in the Latvian language. Applications for the posts should be sent to reach the Dean of the Mathematical-Natural Science Faculty of the University not later than November 1.

THE University of London Commerce Degree Bureau and Appointments Board has issued a useful little pamphlet entitled "Information as to Appointments and Careers for Graduates and Students." It has nineteen chapters on as many different classes of occupation — Teaching, Commerce and Industry, Civil Service, The Church, Law, Medicine, etc.—and concludes with a bibliography and "list of useful addresses." Copies are obtainable (price 1*s*., post free; to members of the University of London, 6*d*.) from the Secretary of the Board, 46 Russell Square, London, W.C.1.

EDUCATION in relation to foundry work forms the subject of a useful report drawn up for the Board of Education by one of H.M. Inspectors, with the advice and assistance of Profs. C. H. Desch and C. A. Edwards. The unsatisfactory conditions affecting recruitment and training in the foundry trades have for some time engaged the attention of the British Cast Iron Research Association, the Non-Ferrous Metals Research Association, and other bodies. Unless these are improved, the general standard of foundries in Great Britain, even now lower than in the United States and several countries in Europe, is bound to deteriorate.

THE Indian Universities Conference held in Simla last May is the subject of an article in the June issue of the *Indian Review* by Mr. P. J. Hartog, Vice-Chancellor of the University of Dacca, formerly Academic Registrar of the University of London. One of the most important of the 44 resolutions passed by the conference was one proposing the establishment of an Advisory Board for Scientific Research, to comprise the heads of the scientific departments of the Government of India and a representative of science nominated by each of the Indian universities and by the Indian Institute of Science, Bangalore, with powers to co-opt representatives of other recognised institutes of science not affiliated to any university. There already exists a committee for medical research in India which has accomplished valuable work, showing that co-operation of this kind is practicable in India. Mr. Hartog infers, from the sympathetic reference made to the project by the Member for Education, that it may be realised at an early date. Commenting on the unanimous decision of the conference to request the Government to exempt scientific apparatus and chemicals for universities and other approved educational institutions from the payment of the 15 per cent. customs duty, Mr. Hartog remarks: "It seems absurd that while the charge on power-driven machinery is only two and a half per cent., that on brain-driven machinery is six times as great. The educational industry in India is a key industry, I might say the master-key industry, which perhaps needs more encouragement than any other."

THE purpose of education in schools is discussed at some length by the president of the Carnegie Foundation for the Advancement of Teaching in his annual report for 1922–23. The educational revolution which has produced a great machine for the many in place of a personal direct agency for the few has brought with it certain dangers. The school began as an agency for the development of the individual, for the discipline of the mind and character, by methods involving intimate touch between teacher and pupil. The machinery of organisation necessary for giving effect to the modern doctrine of universal compulsory education tends to obscure this purpose and the fundamental truth, stressed by the Archbishop of York in his address on April 21 to the National Union of Teachers, that in the development of a human soul it is not the amount of information absorbed that counts, but the ability to think clearly and to bring out the right answers to the problems that present themselves in after life. For this the school is dependent on living contact between the growing mind of the child and the cultivated mind of a teacher whose primary qualifications must be intellectual sincerity and moral simplicity and thoroughness. Paul Klapper, Dean of the College of Education of the College of the City of New York, has contributed to the March-April number of the *American Review* an article on "Educational Aims and Social Progress," in which he similarly urges that education should "make power rather than information its final hope." This conception of the function of the school implies a demand for the critical examination and, when necessary, simplification of existing curricula and limitation of the size of classes.

THE London County Council has issued a Handbook of the lectures and classes for teachers which have been arranged for the season 1924–1925. These lectures play an important part in connexion with the education of the Londoner. The successful teacher must always remain a student, and these lectures are designed to bring him into touch with the latest developments in educational methods and to give him opportunities of hearing leading authorities on their own subjects. Any person engaged in teaching in London is eligible for admission at fees which average less than 1*s*. a lecture, while out-county teachers and others are admitted at fees 50 per cent. higher. The lectures scheme is self-supporting, and last year the attendance was more than 16,000. Among the courses and lectures of interest to scientific workers are the following: Prof. C. K. Tinkler (6), on fuels and ventilation; Prof. A. Morley Davies (6), on the geology and geography of the London basin; Prof. E. J. Garwood (10), on the scenery of Switzerland and its origin; Prof. E. H. Neville (6), on the elements of the theory of curvature and curvilinear co-ordinates; Mr. P. Abbott (10), on the teaching of arithmetic; Prof. T. P. Nunn (9), on the teaching of mathematics, trigonometry, and map-projection, and (5), on the teaching of physical science; Dr. C. W. Kimmins (3), on modern movements in education; Mr. W. H. Winch (3), on the conditions of valid experiment in pedagogical methods; Dr. F. H. Hayward (5), on individual versus mass methods in education; Prof. Cyril Burt (5), on mental and scholastic tests; Dr. Charles Singer (10), on the history of science; Prof. C. A. Carus-Wilson (5), on the teaching of science in secondary schools; Capt. P. P. Eckersley (4), on wireless telephony and broadcasting; Mr. Richard Kearton (5), on wild life round London; Maj. T. F. Chipp (5), on Kew Gardens. Special single lectures are to be given by Sir Ronald Ross on malaria and mosquitoes (October 4), and by Prof. Karl Pearson on the relationship of mind and body (November 15). Copies of the Handbook can be obtained from the County Hall, Westminster Bridge, London, S.E.1.

Early Science at the Royal Society.

August 30, 1663. Mr. Colwall gave in an account which he had received in a letter from the governor of St. Helena, concerning the tides, winds, springs, spouts, and weather there.—Mr. Colwall also mentioned, that Mr. Thorowgood, a master of a ship, who had received instructions from the society for the East-Indies was returned, and had some account to give of what he had done for the society in his voyage; which he was desired to bring in.—Mr. Hooke produced his explications of the new sounding instrument, and of the vessel, that fetched water from the bottom of the sea; and of the engine for determining the force of gunpowder by weight. He was directed to draw the figures in great against the next meeting.

1666. Sir Theodore de Vaux produced some papers, which were read, containing a relation of a furred robe, made of the skin of the Tartarian boramez, supposed to be a plant animal; which robe was said in that paper to be kept in the library at Oxford, to which it was given by Sir Richard Lea, ambassador in Russia in the reign of Queen Elizabeth. Dr. Wren was desired to inform himself concerning this robe, and to view it on his return to Oxford.—Sir Robert Moray mentioned, that the King had been discoursing of ant's eggs, and inquiring how they came to that bigness, which sometimes exceeded that of the insect itself.

September 2, 1663. The experiments of closing up of gunpowder, *Aurum fulminans*, and water, in three balls of steel severally, being again made; and that with gunpowder alone being fired and broken, it was debated, what might be the cause, that the gunpowder should fire, and not the gold powder; the latter being the stronger of the two?—Some conceived, that a sulphureous matter might exude out of the heated steel, and be communicated to the gold powder, whereby its fulminating virtue might be deadned.—Others thought, that this powder might fire within the ball (having left some air in it, because not filled full with the powder) and the noise not be heard at a distance. Others were of opinion, that the penning it in, and giving it but a slow heat, might make it melt. It was ordered hereupon, that the operator should bespeak two balls with cavities no bigger than a pea, to fill them full severally with *Aurum fulminans* and gunpowder.

September 3, 1662. The president gave an account to the society of his and the council's address to the King in the name of the society, to return their humble thanks to his majesty for his favour in establishing them into a corporation by his letter patent; with his majesty's answer of his peculiar esteem of the society, and his readiness to give them all due encouragement: as likewise of their address of thanks to the lord chancellor [Clarendon] for his readiness to further that business; by whom they were very favourably received, and assured, that it was his purpose to come himself to the society to express his acknowledgments to them.

September 4, 1661. A proposition of Mr. Hobbes for finding two mean proportionals between two strait lines given, was delivered into the society by Sir Paul Neile from the king, indorsed with his majesty's own hand, and was ordered to be registered; as was afterwards the answer to the problem, by lord viscount Brouncker.—Mr. Wren was desired likewise to deliver a copy of his observations and hypothesis of Saturn to the amanuensis, to be transmitted by Sir Kenelme Digby to Monsieur Frenich.—It was ordered that a collection of all quicksilver experiments be made, examined, and brought in by Mr. Oldenburg.

Societies and Academies.

PARIS.

Academy of Sciences, July 28.—M. Guillaume Bigourdan in the chair.—Charles **Moureu**, Charles **Dufraisse**, and Marius **Badoche**: Auto-oxidation and antioxygen action. The catalytic properties of sulphur and its compounds: generalisation of the phenomenon. A detailed study of the action of sulphur and its compounds in the catalysis of auto-oxidation. Six oxidisable compounds were selected and a large number of inorganic and organic compounds of sulphur taken as catalysts. A summary of the more important results with benzaldehyde, acrolein, styrolene, turpentine, linseed oil, and sodium sulphite is given.—J. **Bordet**: The current theories of anaphylaxy. A critical review of the various theories which have been put forward to explain anaphylactic shock.—Henri **Jumelle**: Neodypsis and Chrysalidocarpus, palm trees of Madagascar.—F. **Gau**: The equation of the deformation of surfaces.—**Siegle** and **Cretin**: The elastic limit and resistance of annealed mild steels in the case of combined traction and torsion.—Th. **Vautier**: The propagation of explosive waves. An account of experiments on the transmission of sound waves in a tube one metre in diameter and several kilometres in length.—J. **Cayrel**: The influence of the pressure on the working of wireless detectors with solid contact. The pressure should be such that the mean resistance of the detector is of the same order of magnitude as the impedance of the circuit associated with the detector. If the impedance of the circuit is high the pressure should be small.—F. **Wolfers**: Interference by diffusion.—P. **Lebeau** and M. **Picon**: The action of heat and a vacuum on artificial graphite. In an apparatus described in an earlier paper the authors have utilised an electrically heated graphite tube. A preliminary study of the tube was necessary to determine the nature and amounts of the gases given up to a vacuum on heating. The present communication gives the results obtained.—Robert **Stumper**: The kinetic study of the decomposition of calcium bicarbonate in aqueous solution by heat.—Mlle. Jeanne **Liquier**: The anomalous rotatory dispersion of acid solutions of nicotine in relation with the concentration in hydrogen ions.—C. **Matignon** and C. **Faurholt**: A new synthesis of oxalic acid. At a temperature of about 470° C. and under a pressure of about 240 atmospheres, carbon monoxide reacts with potassium carbonate and some potassium oxalate is formed. The highest yield was 27 per cent. of potassium oxalate.—A. **Cornillot**: The constitution of phthalonic acid. Researches on its combinations with aniline. In the reactions studied, phthalonic acid reacts principally as an oxylactone, but a small proportion is clearly shown to react in the ketonic form.—Mme. Pauline **Ramart**: Molecular transpositions. The preparation and dehydration of 1:1:3-triphenyl-2:2-dimethyl-1-propanol. This compound on heating to 325° C. in the presence of infusorial earth gives isobutylbenzene and benzophenone; dehydrated with acetic anhydride and acetyl chloride, two isomeric hydrocarbons, $C_{23}H_{22}$, are produced.—E. **Asselberghs**: The existence of a fault in the French Ardennes.—J. **Savornin**: Geology of the Haut Guir and of the Moyenne Moulouya (Morocco):—L. **Gazaud**: Zones of silence. The zone of direct hearing, concentric with a focus of sound emission, is of very limited range; the zone which succeeds it is alternately one of hearing or of silence according to the presence or absence of high compact clouds.—Ph. **Schereschewsky** and Ph. **Wehrlé**: Perturbation currents and the polar front.—H. **Colin**

and A. **Grandsire**: Green leaves and chlorotic leaves: the ternary materials.—I. A. **Christiansen**, G. **Hevesy** and Sn. **Lomholt**: Researches by a radio-chemical method on the circulation of lead in the organism. There is an essential difference between the results obtained with bismuth and with lead. The quantities of lead accumulated in the liver and eliminated by the fæces are greater, at the expense of the amounts found in the kidneys and urine. With bismuth the latter organs play the principal part in elimination.—A. **Fernbach** and I. **Stoleru**: The influence of the reaction of the medium on the antiseptic properties of the hop. The antiseptic power of hops depends essentially on the hydrogen ion concentration of the culture medium.—E. **Kayser** and H. **Delaval**: Contribution to the study of wine yeasts.—Henri **Stassano** and A. **Rollet**: The carbonic acid removed from milk by the usual method of pasteurisation. The advantage of treatment in a closed circuit.—A. **Demolon** and Mlle. V. **Dupont**: The resistance of soils to acidification.—R. **Argaud** and D **Clermont**: The glandular behaviour of the chordome.—Robert Ph. **Dollfus**: Polyxenia and progenesis of the metacercaria larva of *Pleurogenes medians*.

CAPE TOWN.

Royal Society of South Africa, July 16.—Dr. A. Ogg, president, in the chair.—D. J. **Malan** and D. E **Malan**: The spermatogenesis of *Locustana pardalina* (Walker) (The Brown Trek Locust.) The chromosome numbers in more than 40 genera of locusts have been worked out, and in practically all cases it has been found that 2n = 23 (male) and 24 (female). The few exceptions could all be accounted for by secondary linkage of non-homologous chromosomes.—H. O. **Monnig**: A new trichostrongylus from South African sheep. A description is given of *Trichostrongylus rugatus* n. sp. which occurs in the first 8 to 12 feet of the small intestine in South African sheep.—K. H. **Barnard**: The digestive canal of Isopod Crustaceans. The stomach (fore-gut) in a large number of Isopods of various families has been compared with that of Ligia, which may be taken as a basic type. A general agreement exists between the stomachs of omnivorous or herbivorous forms and those of parasitic forms, but with certain modifications due to the physiological differences in the mode of obtaining nourishment.—John **Hewitt**: Facts and theories on the distribution of scorpions in South Africa. The prevalence of primitive types in South Africa seems definitely against the probability of a South African origin for the families concerned. Assuming that the region of greatest differentiation of a group is its centre of dispersal, then we must look to Eurasia as the immediate source of scorpion fauna. But in most of the genera we find clear evidence of local evolution. These centres are different for different genera. Lines of gradational series of forms are explained as phylogenetic series ranged along former routes of migration, the simplest and oldest forms having migrated farthest from the centre of origin.—A. W. **Veater**: (1) Note on covariants and invariants of binary quantics. (2) Note on differential invariants of the group of homographic transformation of a plane and of certain sub-groups.

SYDNEY.

Royal Society of New South Wales, July 2.—Dr. C. Anderson, president, in the chair.—A. R. **Penfold**: The essential oil of *Backhousia sciadophora* (N.O. Myrtaceæ) F.v M. The leaves and terminal branchlets yielded about 0·3 per cent. of a dark brown oil, which was found to contain about 80-85 per cent. *d-a*-pinene, the remainder being sesquiterpene, sesquiterpene alcohol, with small quantities of phenol and caprylic acid ester. The constants obtained were as follows: Specific gravity, 15/15° C., 0·8799-8802; optical rotation, +33·7-34·2°; refractive index, 20° C., 1·4704 to 1·4717; solubility in 80 per cent. alcohol, insoluble in 10 volumes.—A. R. **Penfold** and R. **Grant**: The germicidal values of the pure constituents of Australian essential oils, together with those for some essential oil isolates and synthetics. The Rideal-Walker tests were carried out as described in previous communications, the following results being obtained: Linalool (13), linalyl acetate (5·25), coumarin (4), vanillin (3·5), isoemethone (14), methyl eugenol ether (13·5), darwinol (13), darwinol acetate (3), bornyl acetate (6), amyl salicylate (4), benzyl alcohol (5·25), benzyl acetate (2), benzaldehyde (9), anthranilic acid (aqueous solution, 2, ethyl alcohol, 12), methyl anthranilate (6·5), anethole (11), anisaldehyde (7), cinnamic aldehyde (17), menthol (synthetic) (20), menthol (natural) (20), valerianic acid (2), ethyl valerianate (4·5), propyl valerianate (8), butyl valerianate (10), isobutyl valerianate (8·5), amyl valerianate (5), menthyl valerianate (3), benzyl valerianate (6), phenyl ethyl valerianate (4), geranyl valerianate (2), rhodinyl valerianate (1), citronellyl valerianate (2).—A R. **Penfold** and F. R. **Morrison**: Notes on *Eucalyptus piperita* and its essential oils, with special reference to their piperitone content, part i The leaves and terminal branchlets yielded from 2 to 2·5 per cent. of pale yellow oil possessing the following constants. Specific gravity, 15/15° C., 0·8924-0·9016; optical rotation, −52° to −64·6°; refractive index, 20° C., 1·4805-1·4821; solubility in 70 per cent. alcohol, 1 in 5·3 to 9 volumes; piperitone contents, 42-48 per cent. These results are considerably different from anything that has previously been published respecting this species, and the authors have come to the conclusion that there are two forms of this tree. It is the first time that the composition of the oil, as obtained by Surgeon-General White in 1788 from trees of this species growing around Sydney (considered to be the type), has been revealed, the results published by Baker and Smith from material obtained outside of the Port Jackson district being from another form of the species, now termed the mountain form or variety "A." This latter has been found to yield only 0·6 to 0·8 per cent. of oil containing less than 10 per cent. piperitone.

Official Publications Received.

Supplement to the Journal of the Indian Mathematical Society, Vol. 15. Report of the Fourth Conference of the Indian Mathematical Society, held at Poona in April 1924. Pp. ii+32. (Madras: Indian Mathematical Society.)

The North of Scotland College of Agriculture. Calendar, Session 1924–1925. Pp. viii+164+xxiii. (Aberdeen.)

Diary of Societies.

THURSDAY, SEPTEMBER 4.

IRON AND STEEL INSTITUTE (at British Empire Exhibition), at 10.30 A.M.—L Aitchison and G. R. Woodvine. Changes of Volume of Steels during Heat Treatment.—C. Benedicks and V. Christiansen: Investigations on the Herbert Pendulum Hardness Tester.—E. D. Campbell and G. W. Whitney: The Effect of Changes in Total Carbon and in the Condition of Carbides on the Specific Resistance and on some Magnetic Properties of Steel.—Prof. C. A. Edwards: Pickling: The Action of Acid Solutions on Mild Steel, and the Diffusion of Hydrogen through the Metal.—Dr. J. Newton Friend and W. E. Thorneycroft: Examination of Iron from Konarak.—M. A. Grossman and E. C. Bain: The Nature of High-Speed Steel.—A. Hultgren: Improvements in the Brinell Test on Hardened Steel, including a New Method of producing Hard Steel Balls.—Dr. W. Rosenhain: Present Position of the Theories of the Hardening of Steel.—F. C. Thompson and W. E. W. Millington: The Effect of Free Surfaces on the Plastic Deformation of Certain Metals.—Ferrous Alloys Research.—Part I. Introductory, Dr. W. Rosenhain; Part II. Iron and Oxygen, F. S. Tritton and Dr. D. Hanson; Part III. The Estimation of Oxygen in Pure Iron, T. E. Rooney. (Papers 6, 1, 4, 9 will be read and discussed.)

FRIDAY, SEPTEMBER 5.

IRON AND STEEL INSTITUTE (at British Empire Exhibition), at 10.30 A.M.—(Papers 10, 8, 7, 2 from list given above will be read and discussed.)

SATURDAY, SEPTEMBER 6, 1924.

CONTENTS.

Editorial and Publishing Offices:
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.

Editorial communications should be addressed to the Editor.
Advertisements and business letters to the Publishers.

Telephone Number: GERRARD 8830.
Telegraphic Address: PHUSIS, WESTRAND, LONDON.

Plant Quarantines.

THE raw material of vegetable origin produced in the British Empire for consumption as food or use in industry is of infinite variety and immense value. Rubber in Malaya, tea in India and Ceylon, cocoa in the Gold Coast, jute, cotton, rice, and oil-seeds in India, wheat and fruit in Canada and Australia, all represent interests of primary importance. It is natural, therefore, to find close attention paid to safeguarding the health of the plant world throughout the Dominions and Colonies, and in recent times there has grown up a system of barriers directed against the free circulation of living plants that might serve to introduce plant pests and diseases.

It has been recognised for some time that insect, fungous, and bacterial parasites of plants are readily transported from one part of the world to another with the living host-plants on which they feed, but not so readily in any other way. Many of these organisms are delicate and short-lived, requiring food and more or less congenial conditions to enable them to survive long journeys. On that account many have remained, probably for centuries, restricted to their proper habitat—the localities in which they are "indigenous." Increased facility of communication, and the opening up of large areas to the cultivation of crops that are often exotic, have greatly increased the chances of dissemination and harmful activity of these pests. Country after country has had its lesson in the invasions of insect and cryptogamic parasites of crops, and in many cases these have been traced to introductions from overseas similar to those to which attention was directed in England by the import of wart disease of potatoes and American gooseberry mildew.

To prevent these events, or at least to reduce their frequency, a series of plant quarantines is now in force in practically all parts of the Empire. It is, in many countries, easier for an alien to land than for a living plant to be secured entry from overseas. Permits to import have to be obtained by the importer, certificates of health and freedom from danger have to accompany the consignment, and an army of inspectors is occupied in granting these certificates and in re-inspecting the plants on arrival at the ports of entry.

Such restrictions are undoubtedly hampering to the export trade in nursery stock, and even, at times, to bulk trade in agricultural produce. In 1914 an abortive attempt was made to secure international agreement in establishing a common basis for facilitating commerce in living plants, through the International Phytopathological Convention of Rome. A further attempt is to be discussed shortly under the ægis of the International Institute of Agriculture in Rome.

Advantage was accordingly taken by the Ministry of Agriculture in Whitehall of the presence of a body of Dominion and Colonial botanists and plant pathologists, who were attending the Empire mycological and botanical conferences earlier in the month, to call a conference on July 17 to consider the whole matter. This conference was attended by a number of the scientific and administrative officials responsible for the application of plant quarantine measures in England and overseas, by many botanists and mycologists, and by representatives of the trade. The opportunity was taken for a frank discussion of the various interests affected by these measures, and of the scientific bases for their application.

There is no possibility of the producing countries withdrawing altogether their restrictions of plant imports. Nevertheless, there is a strong body of opinion that total prohibition may easily be carried too far, and that prohibitions should be as few as possible and carefully scrutinised from time to time, especially so as to avoid rejection of consignments because of a small percentage of infection with some pest already widespread in the importing country. It is felt that in some cases prohibitions are inspired by distrust of the methods of disease control in the exporting country and of the efficiency of the inspecting service which certifies to the health of export consignments. Such distrust can only be remedied, on one hand, by the establishment of really efficient methods of control and inspection, and on the other, by a closer contact between the services of the different countries, such as is secured by conferences of this nature. Without mutual confidence in the plant health services, increased facilities for trade in living plants are unlikely. There is a feeling that matters are improving in this respect, and it is hoped that ultimately some amelioration of the regulations now in force may result.

The common bases for international agreement are somewhat scanty at present. Only three were formulated at the meeting, namely, (1) that every country should have the right to impose prohibition of imports with the view of restricting the risk of introducing diseases, (2) that no country had a right to ask another country to accept its exports before it had established effective plant disease control within its own borders, and (3) that no country was entitled to make a similar request unless it maintained an efficient inspection service and proper arrangements for giving health certificates. Indeed, in a general way the chief result of the conference is a recognition of the fact that a country must set its house in order before it can secure such confidence in the health of its consignments as will facilitate their admission into other countries.

Exploration in Central Asia.

Records of the Survey of India. Vol. 17: *Memoir on Maps of Chinese Turkistan and Kansu, from the Surveys made during Sir Aurel Stein's Explorations, 1900–1, 1906–8, 1913–15.* With Appendices by Major K. Mason and J. de Graaff Hunter. Pp. xv+208+30 plates (+48 maps+12 charts, separate). (Dehra Dun: Trigonometrical Survey Office, 1923.)

THIS memoir is a record of the geographical surveys carried out by Sir Aurel Stein during his explorations in Central Asia, and is accompanied by 47 maps of the mountainous and desert countries north of Tibet. Stein's journeys were primarily undertaken for archæological exploration, but he made use of his opportunities for geographical surveying. The geographical world owes a debt of gratitude to Stein for his surveys of these inhospitable regions; his maps will for many years to come be the main source of our geographical knowledge of this portion of Asia. The maps have been printed in colours by the Survey of India, and the memoir furnishes information as to their history; there is an appendix on Stein's triangulation written by Major Mason, the triangulator of the Hindu Kush, and there is another appendix on Stein's heights by Dr. Hunter, the mathematical adviser of the Survey.

The theatre of Stein's explorations has been the great mountain horse-shoe of Central Asia, known as the Tarim basin; the Tarim river collects the waters from the glaciers surrounding the basin, and carries them eastwards until they are choked and lost in the desert of sand. The plains of the Tarim horse-shoe have an easterly opening into the Gobi desert of China; on the south they are shut in by the snowy ranges of Tibet, on the west by the Kashgar range of the Pamirs, and on the north by the Tian-Shan mountains. Inside the basin the sand is increasing owing to the disintegration of the surrounding mountains and to the decrease of the surrounding glaciers.

Many parts of the earth have been discovered by geologists to have undergone a slow desiccation in the course of ages. But Stein's surveys have shown that the Tarim basin has suffered a rapid desiccation during the last 2000 years. The volume of water available for irrigation has decreased considerably within historic times; the relics recovered by Stein from the sand-buried sites of ancient towns have shown that the latter were abandoned about A.D. 400; a long line of ruined boundary towers has been proved by his investigations to date from 200 B.C.

It was in 1898 that Stein first approached the Trigonometrical Survey of India and asked for their

co-operation in his scheme for exploring the ancient sites buried under the sands of Tarim. The Superintendent of the Survey was then Colonel Gore, and when we now look back upon the brilliant successes that have attended Stein's three expeditions, we cannot but feel that this first meeting between the experienced frontier surveyor and the young ambitious archæologist has led to great results. At this meeting was founded the alliance between the Trigonometrical Survey and Stein, an alliance that has lasted without a break for a quarter of a century.

Stein has now carried out three expeditions. On his first expedition (1900–1901) he was accompanied by Surveyor Ram Singh, and it was on this expedition that he discovered the extensive ruins of Niya, which have been abandoned to the sands since A.D. 300. It was on this expedition that the peak of Kongur (25,146 feet) was definitely proved to be higher than the famous Mustagh Ata (24,388 feet), which had hitherto been believed to be the highest point of Asia north of the Himalaya-Karakoram mountains. In observing the clusters of peaks round Kongur, Surveyor Ram Singh made a mistake that is not uncommon in mountain surveys; he mistook the identification of different peaks as seen from different places, and from his observations the Trigonometrical Survey drew the conclusion that there were two Kongur peaks, both higher than 25,000 feet; this is now known to have been incorrect; there is but one true Kongur peak (height, 25,146 feet), and it is depicted in the second photograph of the Memoir. It may be recalled that Schlagintweit made the same mistake as Ram Singh, when he was observing Mount Everest sixty years ago, and that Schlagintweit's error of identification led to the name of Gaurisankar being wrongly applied to Mount Everest, a geographical blunder that has been unfortunately perpetuated in the new *Times* Atlas.

On Stein's second expedition (1906–1908) Rai Sahib Ram Singh again accompanied him, but his health gave way under the hardships of the work and he was relieved in 1907 by Surveyor Lal Singh. On this second expedition Stein's feet were severely injured by frost-bite, and he had to be carried back to Leh in Tibet, where the toes of his right foot were amputated. On the third expedition (1913–1915) Stein was again accompanied by Surveyor Lal Singh, who had displayed exceptional zeal and fitness for surveying under trying conditions.

The discoveries by Sir Aurel Stein of the relics of a vanished population who had had to struggle for generations against the encroachments of sand took geographers by surprise. This people, whose rivers had been choked and whose towns had been buried, were found by Stein to be of a higher civilisation than that prehistoric race which was similarly driven from its homes in Europe by the advancing glaciers of the ice-age. The entombment of the Tarim towns was not sudden like that of Herculaneum and Pompeii, but it was as complete. Stein's descriptions [1] of the ancient sites have gained for him so high a reputation as an archæological explorer that his contributions to geography are apt to be overlooked, and for this reason the publication of the new Memoir will be welcomed.

[1] "Sand-buried Ruins of Khotan," 1904; "Ancient Khotan," 1907; "Ruins of Desert Cathay," 1912; "Serindia," 1921.

Mathematics of Relativity.

(1) *Introduction au calcul tensoriel et au calcul différentiel absolu.* Par Prof. G. Juvet. Pp. iv+101. (Paris: Albert Blanchard, 1922.) 12 francs.

(2) *From Determinant to Tensor.* By Dr. W. F. Sheppard. Pp. 127. (Oxford: Clarendon Press; London: Oxford University Press, 1923.) 8*s*. 6*d*. net.

(3) *Qüestions de Mecànica Clàssica i Relativista. Conferències donades el Gener de 1921.* Per Prof. T. Levi-Civita. (Publicacions de l'Institut de Ciències. Collecció de Cursos de Física i Matematica.) Pp. viii+151. (Barcelona: Institut d'Estudis Catalans, n.d.)

(4) *Les Axiomes de la mécanique (Examen critique): Note sur la propagation de la lumière.* Par Prof. Paul Painlévé. (Les Maîtres de la Pensée scientifique.) Pp. xvii+112. (Paris: Gauthier-Villars et Cie, 1922.) 3 francs.

(1) ONE of the most interesting features of Prof. Juvet's book on the calculus of tensors is the preface by Prof. Hadamard. In discussing the value of a book that deals with the pure mathematical theory of tensors, Prof. Hadamard has some hard things to say about the geometrical work of recent years. Henri Poincaré once said: "The physicist expects us to solve the problems that he sets us. But in setting us these problems he pays us in advance for the service we do him in solving them. The numbers and symbols of mathematics can form an infinite number of combinations. Of all this multitude how are we to choose those that are worthy of our attention? Should we be guided solely by caprice? . . . The study of physics prevents us from losing ourselves, or, more important still, prevents our moving constantly in a circle." Prof. Hadamard thinks that this danger of losing ourselves in a mist of symbolism or of moving continually in a circle of barren argument is, in fact, a characteristic of the innumerable researches of recent years, where "the classical ideas of Gauss, Ossian Bonnet, and Darboux reappear untiringly in all

possible orders, somewhat like the performers in a circus, or like the pieces of red, green, and blue paper that our children are made to put together at school in accordance with the methods of Froebel." Prof. Hadamard concludes: "Whatever view we may hold of the value of the new hypotheses of Einstein's theory, they give geometry a new rôle, and open out for her a new lease of life . . . full of infinite fertility. . . ."

For this reason and others, Prof. Hadamard welcomes M. Juvet's book, which is indeed a very good account of the main features of the pure mathematical aspects of the geometry of relativity. The theory of vectors is developed into the theory of linear transformations of vectors, and so into the theory of tensors, followed by the theory of quadratic forms and the tensors of generalised space. The illustrations of the meaning of the quantities g in the case of two- and three-dimensional space are very helpful. There is also a good account of the theory of parallelism according to Levi-Civita and Ricci.

(2) Dr. Sheppard's aim is similar to that of M. Juvet, and he carries it out with equal success. His point of view is distinctly different, due to the fact that he is interested in algebra rather than in geometry. The book consists of two parts—the first dealing with Determinants, the second with Sets. Basing himself on the possibility that a reader who wishes to study tensor methods may be insufficiently acquainted with the necessary determinant theory, Dr. Sheppard devotes five chapters to the subject. One may reasonably suppose that a reader unacquainted with determinants will scarcely be fired with ambitious schemes like the study of tensor theory, and that, in the rare event of this happening, his eagerness is quite unlikely to survive the shock of the author's eminently and severely logical presentation of the theory. We may, however, express the belief that Dr. Sheppard's real aim is to instruct the reader who does "know" determinants, and to lead him on to the algebraic point of view as applied to tensors in the second half of the book: at any rate all readers will find the chapters on determinants a useful and interesting repetition of theory that most students know rather vaguely. There are also one or two deviations from usual notation to add zest to the repetition.

From the theory of reciprocal determinants Dr. Sheppard introduces sets, double sets, and sets of higher ranks, and thus paves the way for the second part of the book, where the sets of arithmetical quantities become sets of variable quantities and finally tensors. He adopts the Einstein contracted notation for summation, but develops a notation calculated to avoid all misconception, one feature being that Einstein's contracted notation is used only with Greek suffixes.

As already remarked, the book is algebraic, as opposed to Prof. Juvet's geometrical point of view. It is true that Dr. Sheppard gives a chapter on the theory of tensors as applied to relativity; but even here the aspect is analytical only, and it would be possible for a reader who did not know what the theory of relativity is about to read the book without suspecting that the subject is at bottom connected with geometrical concepts.

Mention must be made of Chapter xi., which deals with the use of tensor calculus in the theory of statistics, based upon recent papers by the author and by Prof. Eddington.

The book is one that all English readers of the mathematics of relativity should study attentively.

(3) and (4) The books by Prof. Levi-Civita and Prof. Painlévé are not primarily concerned with relativity as such. The former is a set of four lectures delivered by the distinguished Italian mathematician at Barcelona in January 1921, the subjects being the problem of three bodies, the propagation of waves in water canals, parallelism and curvature in generalised space, and geometrical optics as applied to Einstein's theory. The second book is a reprint of an essay by the famous French mathematician and statesman on the axioms of classical mechanics, first published in 1909, as well as an essay on the principles of mechanics and causality, published in 1905 in the Bulletin de la Société Française de Philosophie. An introduction and notes on relativity theory have been added to the present reprint.

If we associate these two books with the other books of this joint notice, it is because the chief interest of Prof. Levi-Civita's book must lie mainly in the masterly exposition of the theory of parallelism—one of the pioneering stages in the mathematics of generalised relativity, while in the case of Prof. Painlévé's book the reader can at once see that the republication of these two essays was dictated and motived by the relativity controversy.

The fundamental notion of the theory of parallelism is easily seen as follows. A developable surface consists of a number of generators. Suppose that the surface is developed into a plane: two generators which then become parallel are said to be parallel (in the generalised sense) when the surface is not developed, and the directions of any two elements of curve on the developable can be related in the same way. Now we can fit a developable surface to any curve drawn on any given surface, the developable touching the surface at all points of the curve: hence we can define parallelism between elements of curve on any surface. Developing the analytical conditions for such

parallelism and extending to any number of dimensions or variables, we are led to the general theory of geodesics, and to the equations that play so important a part in defining the motion of a particle in Einsteinian space.

Turning now to Prof. Painlévé's book, we have to preface the remark that his attitude towards relativity is one of caution, as shown both by the present publication and by other contributions on the subject elsewhere. "The theory of relativity is like very strong wine, that inebriates brains which are insufficiently accustomed to the rigorous discipline of science": for this reason the author advises particular attention to the fundamental axioms of the classical laws of mechanics, in order that he who wishes to study the modifications involved in relativity theory may at least know what is being changed! Incidentally, Prof. Painlévé mentions one or two common errors in the presentation of Einstein's theory. The first is in the suggestion that the Lorentz transformation applies when the relative velocity of two observers is uniform: the transformation is really laid down only for the case where each observer's motion is uniform relative to the "absolute" space of Newton, or to the system of fixed stars. Another error is the statement that, according to the theory of relativity, the laws of Nature are the same to all observers: of course, this is only true in the sense that certain fundamental differential equations are satisfied independently of the particular frame of reference, its type or its motion. It need scarcely be said that the errors here mentioned are almost inevitable consequences of the attempts made to put exact mathematical statements into vague and "intelligible" language.

Prof. Painlévé insists on the existence of *privileged* axes of reference in actual fact: but whereas in classical mechanics we speak of these axes as absolutely fixed, or as moving with uniform velocity relative to absolutely fixed space, in relativity mechanics these axes are at rest in, or move with uniform velocity relative to, the totality of bodies in the universe. Axes with origin at the centre of mass of the solar system, and in directions fixed relative to the *ensemble* of material bodies in the universe, Prof. Painlévé calls *Copernican* axes: axes moving uniformly relative to these are called *Galilean*, as is the custom in most modern writings on the mechanics of relativity

The author, in fact, attributes a very important place in the evolution of the fundamental axioms of mechanics to the influence of Copernicus. Given forces acting on a given system of bodies will make the system assume a configuration which at any moment depends on these forces, on the time, and on the conditions at zero time—the *initial conditions*. Now what are these initial conditions? Prof. Painlévé attributes to Copernicus the germ of the principle of classical mechanics, namely, that the initial conditions comprise both *position* and *velocity* of each particle of the system.

Prof. Levi-Civita's book gives also a brief account of the optical properties of Einsteinian gravitational fields in a manner leading up to the discussion of the light bending in the sun's field. The other two lectures give excellent accounts of important modern topics. The lecture on the problem of three bodies is on the regularisation of the problem; *i.e.* putting the equations of motion in such a form that singularities due to the possible vanishing of the distance between two of the particles are made to disappear, so that the variables can be obtained, theoretically, as functions of the time for all values real and finite. Sundmann's fundamental investigations are explained, and the later work by the author and others, leading to the regularisation of the restricted problem of three bodies, and of the general problem in three dimensions. The lecture on waves is one of Prof. Levi-Civita's characteristic investigations in two-dimensional hydrodynamics, reducing the problem of the propagation of waves of permanent type to a functional equation, with Airy's formula for surface waves and other approximate results as special cases.

Prof. Levi-Civita's book will be of interest to all who wish to keep abreast of modern research in problems of applied mathematics. Prof. Painlévé's book should be read and re-read by all students and teachers of mechanics.

S. BRODETSKY.

Theories of Colour Vision.

An Introduction to the Study of Colour Vision. By Sir John Herbert Parsons. (Cambridge Psychological Library.) Second edition. Pp. x+323. (Cambridge: At the University Press, 1924.) 25*s.* net.

SINCE all knowledge comes to us primarily through the evidence of the senses, it is unavoidable that some of the greatest controversies which have occurred in the development of the sciences should have been centred around the *modus operandi* regulating the translation of the energy of a physical stimulus into the energy of thought. It is also not surprising that the fiercest and most prolonged of these battles, not yet concluded, should have originated in connexion with the sense of sight, whereby we come most widely and most directly into relation with our external surroundings. These struggles have resembled no merely local disputes. They are prolonged campaigns conducted on the common borderland of three great territories; and they cannot cease until "natural" delimitations are determined as the result of statesmanship rather than as the result of militant capacity.

In the case of the colour vision controversy, the stage now attained is, on the whole, that of statesmanship, which implies the recognition of essentiality. The chief essentiality was perceived early in the contest by some of the great leaders, but the compulsion behind their conclusions was not adequately perceived until their individual work had ceased. These great leaders, working on wide lines, sought to fix the physical law which dominates visual sensation and is true irrespective of the nature of the structural details which embody it. In such a case, time gradually, and almost imperceptibly, settles the matter.

The record of this process may be traced in Sir John Parsons's work. The dominating law referred to is that of trichromasy in colour mixture. The essentiality referred to is that of trichromasy in colour perception or sensation; but there is not yet universal recognition of the *pari passu* compulsion to trichromasy, *i.e.* a triple set of freedoms only, in the physiological and the psychological processes. Yet Fechner's law is universally recognised as, and is called, a psycho-physical law—the law which relates perception to, and expresses it in terms of, the physical stimuli with regard to the results of which triple freedom is proved. The point is not merely that freedoms cannot be added, while they may be removed, in any subsequent actions having that one-to-one correspondence to precedent actions which Fechner's law asserts to hold between sensation and stimulation under fixed conditions. It is rather that the triplicity is asserted with regard to the sensations themselves. There is no room left for an independent fourth fundamental sensation whether adopted on physiological or on psychological grounds, though it may, for some purposes of description, be convenient to adopt it and use it as if it were independent. A full description cannot then be attained until the connecting linkage is at least formally taken into account.

It is intensely satisfactory to find a physiologist of Sir J. H. Parsons's standing directly speaking (p. 313) of "the trichromatism of normal colour vision, which is a fact, and not a theory." He states quite frankly his recognition of difficulty in connexion with the trichromatic, or, as he calls it, the three components theory, on two points—peripheral vision and the so-called phenomena of induction. He says (p. 231) that "we must therefore accept the theory as explaining satisfactorily *either* the phenomena of after images *or* those of dichromatic vision, but not both." But this view results from a too circumscribed estimate of what the contents of the theory are. In this particular case he speaks of necessary modifications of the theory, while all that is necessary is its legitimate development to suit new facts. The possibilities of the theory are so great that the evidence of new facts is required to place limitations upon it, and that in the very matters of which he speaks. At the top of the same page he states a dilemma arising from the Helmholtzian view of the way in which stimulation by light of one colour increases sensitivity towards the complementary colour. But the trouble only arises because Abney's, or similar, fundamentals are used; and Helmholtz's work on differential sensitivity shows that these cannot be the absolute fundamentals. The dilemma is really non-existent.

Sir J. H. Parsons's volume has filled a great gap in our scientific literature, and will be indispensable as a text-book or book of reference even after the appearance of the American edition of Helmholtz's great work. The treatment which it contains of the observational and the theoretical parts of the subject is very complete, and the discussions of the various outstanding views are fair and full.

The new edition is gracefully dedicated to the memory of Abney and Watson, "worthy successors of Thomas Young and James Clerk-Maxwell in this field of science."

W. PEDDIE.

Chinese Pottery.

The Early Ceramic Wares of China. By A. L. Hetherington. Popular and abridged edition. Pp. 169 + 31 plates. (London: Ernest Benn, Ltd., 1924.) 12*s.* 6*d.* net.

THIS abridged edition of Mr. Hetherington's excellent volume on the early pottery and porcelain of the Chinese artist-craftsmen will be welcomed by all those students who were unable to purchase the large and profusely illustrated volume from which this has been condensed. The work of reduction and compression has been so skilfully carried out that there is little or no loss of matter that is absolutely relevant, and the work here presented will serve as an admirable introduction to a complete knowledge of the subject, and to the more important works to which all of us must turn for the completion of the story of Chinese ceramics, in all its fascinating and masterly developments.

The immediate purpose and scope of this little work cannot be better expressed than by an extract from the preface, where the author writes: "The chapter on technique has been omitted, and so have the chapters on miscellaneous factories and on marks and inscriptions; the present object being to confine attention to the principal features displayed by the wares without digressing into more difficult paths." As an example of the care which has been taken to render this abridged edition usefully complete, one may mention the list of "The Dynastic Epochs of China from the Mythical and

Legendary Periods, before 2205 B.C." (a date which corresponds roughly with that of the XVIth Egyptian dynasty), down to the Yüan dynasty which held sway in China from A.D. 1280 to 1368.

No one could wish for a more sprightly and entertaining guide than Mr. Hetherington through the mazes of the story he sets out to unravel. Wherever possible, the history is enlivened by some amusing story of the remote past or by some shrewd hint which may help to untie a knot of ancient historic fact; yet, always there is the underlying sensibility of the serious student. As an example of this admirable faculty we cannot do better than quote a passage where the author deals with the evidence we now possess that the potters of the T'ang dynasty (A.D. 618–907) knew how to manufacture true porcelain with felspathic glaze.

"The advance in technical knowledge denoted by the manufacture of true porcelain as an alternative to the use of pottery bodies only, and by the use of high-fired felspathic glazes in substitution for the low-fired lead-silicate glazes, could not have been made very rapidly with the scientific knowledge possessed in those days in China. The process must have been evolved gradually by experiments conducted by competent craftsmen, no doubt, but by men without full appreciation of the underlying scientific principles. One feels, therefore, that the Chinese must have known how to use the simpler types of glaze for a very considerable time before the early part of the T'ang dynasty. The general tendency of further research into Chinese ceramics is to antedate rather than to postdate various types of ware."

The reader will welcome the terse and definite exposition of the technical and artistic qualities and characteristics of the many types of pottery and porcelain that are passed in review; no less than the consideration and valuation of the different racial influences, Chinese and other, that brought about the final artistic results. The simplicity of means and directness of aim manifest in the earlier wares is duly and rightly appraised equally with the glorious yet subtle colour-qualities of the Chün *yao* bowls and bulb-pots of the Sung dynasty. In addition, the author gives an interesting summary of our present knowledge of the famous Ting *yao*, with its well-marked varieties of ivory-white or rice-white glaze. Of the purple and black Ting *yao*, once so coveted by Chinese connoisseurs, no specimens can be identified in modern collections in Europe or America, and we are principally dependent for our knowledge of them on the drawings and descriptions in the album of a Chinese collector who lived in our Tudor times.

Naturally, there is a clear, though necessarily summary, account of the renowned Céladon wares, which seem to have been more largely exported at the time of their manufacture than any other variety of porcelain. In addition, the history of the Tz'ŭ Chow wares—made at what must be the oldest pottery-centre in the world that is still in active operation, for it dates back to the Sui dynasty (A.D. 589–618)—has its puzzles for the collector of to-day, for, as is well said, "It is extremely difficult to determine which specimens are of Sung origin and which of Ming or even later date."

In the final chapter we have an account of the Chien wares, which have only been recognised as a distinct class in what we may call recent times. The fascinating glazes which are usually associated with these wares and are distinguished on account of their markings as "hare's fur" or "partridge markings," are usually applied so thickly that in the majority of examples they form a dark pool in the inside and thick running lines with a terminal blot on the outside of the vessel to which they are applied. These special glazes appear to have been most extensively used in the decoration of small bowls which ritual use long ago prescribed for the "tea ceremonial" or tea contests. The Chinese have always been inveterate gamblers, and in this particular "gamble" the idea was to pit the cup of this type owned by one connoisseur against that owned by another to decide which would retain moisture longest. As Mr. Hetherington says, "The game seems a curious one to Western minds, but, after all, roulette has no more claim as a sensible method of gambling." The tea ceremonial was introduced into Corea and Japan, and with it the bowls and other apparatus of the game. The Japanese have made many varieties of these bowls, some of which are difficult to distinguish from Chinese specimens; though any one who collects with an eye to beauty alone may be delighted to treasure a Japanese specimen for its æsthetic worth.

A word must be added in praise of the illustrations, for though there is only one coloured plate (an extremely beautiful one), the half-tone illustrations convey an excellent impression of the objects they represent, and will greatly aid the student in the identification of specimens. WILLIAM BURTON.

Diseases of Wild Animals in Captivity.

Disease in Captive Wild Mammals and Birds: Incidence, Description, Comparison. By Dr. Herbert Fox. Pp. vii+665+91 plates. (Philadelphia, London and Chicago: J. B. Lippincott Co., 1923.) 60*s*. net.

ALTHOUGH it is the custom in most zoological gardens to keep a record of all post-mortem examinations, this is the first time an attempt has been made to correlate the results and place them in a compact form before the medical and veterinary professions.

Dr. Fox has held the post of pathologist at the Philadelphia Gardens for the past twenty years, and during that time has had the opportunity of making post-mortem examinations on 1860 mammals and 3505 birds. In addition to this he has also studied the living animals, and has been able to apply his pathological findings to the diagnosis, treatment, and prophylaxis of disease in general. The result of his work has been of extreme practical value in the management of the Philadelphia Gardens; epidemics have been arrested by scientific disinfection, and certain diseases, such as spiropteriasis in parrots and tuberculosis in monkeys, have been entirely eliminated. In order to prevent the introduction of tuberculosis, every new arrival before being placed in the collection is subjected to the tuberculin test, and the variations of temperature during the ensuing forty-eight hours are recorded. In healthy animals there is no reaction; in tuberculous animals there is usually a definite rise in the first twelve hours. No animal showing a positive reaction is placed on exhibit.

Among other communicable diseases investigated, the "jaw disease" of kangaroos has been made the subject of special research. The causative organism of this disease was found to be one of the Mycobacteriaceæ, which was cultured successfully and a vaccine prepared. It was found to be new to science, and has been named *Nocardia macropodidarum*. From experiments upon laboratory animals with cultures of *N. macropodidarum*, it would appear that the disease is transmitted with difficulty. As it is always found associated with a small Gram-negative bacillus, it is possible that the bacillus is a necessary factor in the production of the disease.

The section on the incidence and significance of animal parasites, by Dr. F. D. Weidman, emphasises the value of zoological gardens in general as a field for research on this subject. Tables showing the pathogenicity and frequency in the various orders are given, and various methods of treatment and prophylaxis are suggested.

The tables giving the relation of diet to disease show that birds and mammals which live on a mixed diet of plant and animal tissue are less liable to disease of the alimentary tract than those which are entirely carnivorous or herbivorous. The percentage of thyroid disease and rickets was highest among the Carnivora.

Neoplasms, both benign and malignant, are treated at some length, and valuable tables are given, showing the type of growth, organ of origin, relation to sex, duration of captivity, metastases, and order of animal affected. Neoplasms were found to be commonest among the Rodentia, Marsupialia, and Carnivora, and rare among the Primates. The main organs affected were uterus, liver, thyroid, and mammary glands.

The book is well illustrated with photographs of microscopical and macroscopical specimens of pathological changes, in addition to numerous interesting and valuable statistical tables dealing with the incidence of disease.

In the foreword, Dr. C. B. Penrose, the president of the Philadelphia Zoological Society, makes some general remarks on some of the problems which arise in relation to the keeping of animals in captivity, and the various mental perversions which are common among them, some of which are akin to prison psychoses in man. Diseases of the central nervous system and special senses are dealt with in a special section, as are the diseases of all the other organs of the body.

There is no doubt that this work, which is essentially a pioneer effort, should be read by every comparative and human pathologist. By those who are concerned in the management of living animals in captivity, it will be found to be a mine of valuable information.

Our Bookshelf.

(1) *Physics.* Vol. I.: *Mechanics, Heat and Heat Engines.* By W. J. R. Calvert. (Science for All Series.) Pp. x+260. (London: John Murray, 1924.) 3*s.* 6*d.*

(2) *A Text-Book of Physics: including a Collection of Examples and Questions.* By Dr. W. Watson. Eighth edition, revised by Dr. Herbert Moss. Pp. xx+976. (London: Longmans, Green and Co., 1923.) 16*s.* net.

(3) *Thermodynamique: Énergétique: Théorie cinétique des gaz (Cours professé à la Sorbonne).* Par Prof. A. Leduc. Pp. iii+333. (Paris: Gaston Doin, 1924.) 25 francs.

According to Dr. George Saintsbury, "A review . . . is a thing addressed to the general body of educated people, telling them whether it is or is not worth their while to make further acquaintance with such-and-such a document purporting to bear their address." Each of the three books included in the present notice has its own merits, but each is addressed to a special class of reader.

(1) The book by Mr. Calvert, who has been a science master at Harrow since 1909, forms the first volume on physics in the "Science for All" Series. It is intended for pupils up to the age of, say, sixteen, who are taking a course of science as part of their general education. For such students the book is a most admirable one, the interest, both from the scientific and the literary point of view, being skilfully sustained throughout. The ideas of work and energy form the main theme, applications being made to the subjects of hydrostatics, statics and dynamics, and heat. In a preface of unusual interest Mr. Calvert discusses the principles underlying the teaching of science in the earlier stages of a general education. Such teaching should give the pupil some idea of the aims of science

and the kind of problems with which it deals; a knowledge of some of the broad fundamental principles; and some insight into scientific method.

(2) Dr. Watson's "Text-Book of Physics," intended for more advanced students, is too well known to require more than the briefest notice. In the revised edition considerable additions have been made to bring the work into line with recent progress, especially in the subject of electricity.

(3) Prof. Leduc reproduces in this volume a course of about thirty advanced lectures on heat delivered at the Sorbonne. He remarks that amongst his hearers future physicists are in the minority; nevertheless, he rightly considers it desirable to consider his subject from the point of view of research, discussing the methods and results of recent investigations, including those he has himself undertaken. Stress is laid on the accuracy of the numerical results, and one of the valuable features of the work is the information (not always easily accessible to the student), which is supplied as to the quantitative values arrived at in the most recent determinations of thermal constants. The book is divided roughly into four parts. The first deals with general questions connected with thermometry, calorimetry, and equations of state. The second and third parts are devoted to the general principles and applications of thermodynamics respectively, whilst the very short fourth part deals with the kinetic theory of gases.

In a few cases the historical references are not complete or accurate. It is probably useless to protest against the constant use of "la loi de Mariotte," but if we cannot have Boyle's law, we would enter a plea for some mention of Joule's law as to the additive nature of the specific heat of compounds. Again, "l'expérience classique de Tyndall" (p. 204), in which a loaded wire cuts through a block of ice, is really due to Lord Kelvin's nephew, Dr. J. T. Bottomley, as is stated in "Heat a Mode of Motion," p. 150 (1887). In spite of some minor defects the book is an excellent one, and an English translation might well appeal to a large number of students. H. S. A.

An Elementary Treatise on Frequency Curves and their Application in the Analysis of Death Curves and Life Tables. By Arne Fisher. Translated from the Danish by E. A. Vigfusson. American edition. Pp. xvi+244. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1922.) 20s. net.

THIS book under notice is divided into two parts; the first gives an account of the Gram-Charlier curves and curve fitting taken, in places verbatim, from the author's "Theory of Probability" and the second part deals with a method of estimating rates of mortality from statistics of the numbers of deaths from various causes at each age. The object in finding a method which will enable the statistician to dispense with censuses, or exposed to risk, when estimating mortality is that in some cases only the deaths are known and in others the trouble and expense of obtaining a census, or exposed, are considerable. The author's method is to choose a system of frequency curves based on the hypothesis that the distribution of deaths according to age from certain groups of diseases can be made to conform to those assumed curves; proportional death rates are calculated for each age (or groups of ages) according to the grouped causes of death. From these figures, by a lengthy arithmetical process, the number dying in a stationary population is reached, and this leads to the rates of mortality. The method is interesting and in some cases it gives results which are in close agreement with those obtained by the usual methods, but, in other cases, the examples given seem to imply that there may be considerable errors in the result, although in these cases a modification of the groupings of deaths might lead to improvement. It would appear from *a priori* considerations that, in some circumstances, it must be impossible to obtain a satisfactory result from deaths alone (compare, for example, two experiences having rates of mortality such that the rates by one are equal to r times the rates of the other at all ages).

The book has many defects; some of them are no doubt due, as is suggested by the author in his preface, to the original Danish MS. of the second part of the book having been translated by an Icelander and to the composition and proof reading having been done by a Copenhagen firm; but the explanation affords little comfort to the troubled reader. Possibly the international nature of its origin accounts for the fact that the book, which is dated 1922, has only recently reached us. Another point open to criticism is the omission of a clear explanation at the beginning of the second part of the theory and assumptions on which the author intends to base his construction of mortality tables, so that a reader has more difficulty than is necessary. We think that the author would have been well advised if he had set out some, at any rate, of the difficulties and criticisms that would naturally occur to his readers and how he would propose to answer them.

The idea and the method are interesting; but the evidence in favour is not conclusive and we are afraid that the remark in Prof. Raymond Pearl's introduction that "it may fairly be regarded as *fundamentally* the most significant advance in actuarial theory since Halley" is an unfortunate over-statement.

Smithsonian Institution. United States National Museum: Bulletin 82. A Monograph of the existing Crinoids. By Austin H. Clark. Vol. 1: The Comatulids. Part 2. Pp. xxv+795+57 plates. (Washington: Government Printing Office, 1921.)

RARELY can there have been produced a work so thoroughly deserving the title of Monograph as this vast production of Dr. Austin Hobart Clark's. The first part, of 387 pages, issued in 1915, dealt with some general principles and began the account of the anatomy; it is unfortunate that the pre-occupations of war prevented it from receiving adequate notice. This second part, continuing the description of the comatulids or feather-stars, completes the details of their anatomy, family by family and species by species. There follows a summary of the development, again with reference to every species in which any larval stage is known. An interesting chapter is that on the various habitats of the littoral crinoids. There follow notes on the habits of Antedon, and then a long, well-documented list of parasites and commensals. Next are brought together the scattered observations, experimental and other, made on the tropisms and relations to environment of numerous comatulids.

The chapter on the colour of crinoids includes the stalked and sessile forms as well as the unstalked. The part ends with a section on the economic value of the recent crinoids; this is confined to their sale as curios, for, we are told, they serve no useful purpose; they are not even eaten by any animal that serves as human food. In this respect it is probable that the recent crinoids have acquired a securer footing than some of their large-bodied ancestors.

These two large books, though they contain only "introductory matter" to the systematic descriptions, already furnish a corpus of nearly every observation ever made on these beautiful creatures, and reference is facilitated by full tables of contents and indexes. Although a great deal of the work is based on Dr. Clark's own observations, especially concerning the skeletal and muscular anatomy, it does not profess to give new facts or original theories. That in no way lessens its great value to the worker, who will also find his wants attended to by various keys and by comparative diagrams. He will be grateful to Dr. Clark and will marvel at the energy and perseverance that have brought him so far along a laborious road.

F. A. B.

The Subject Index to Periodicals, 1917–1919. Issued by the Library Association. L: List of Periodicals Indexed and Author Index. Pp. ix + 103. (London: Grafton and Co., 1924.) 21*s.* net.

THE alphabetical index of names of authors of articles included in the various Subject Indexes to Periodicals issued by the Library Association for the period 1917–1919 has now been published. The index contains more than 20,000 names of authors, with the sections of the Index and the headings under which the titles of their papers are registered. It is estimated that, on an average, each author has published two papers, so that the total number of papers indexed for 1917–19 will be about 40,000. Those who possess the valuable Subject Indexes already published will be able through this author index to find a paper when they have forgotten its title although they remember the author's name. The abbreviations for 477 periodicals used in preparing the indexes for 1917–19 are also given.

The headquarters of the "Subject Index to Periodicals" were transferred to the National Library of Wales, Aberystwyth, in January 1921. The access to periodicals in this Library has been of great assistance to the editors in preparing the indexes. The editors record the voluntary help they have had from some forty-eight libraries in Great Britain and from a number of private contributors. While expressing its grateful thanks to all who have helped in the undertaking since its beginning in 1915, the Library Association makes a strong appeal for assistance to those librarians who have hitherto held aloof from active co-operation in the work.

It is obvious that the value of the Index depends upon its completeness; although up to the present time some 575 periodicals have been examined, some of the libraries that have not yet taken part in the work may very well have on their shelves other periodicals containing relevant matter. We would urge any such libraries to consider whether they cannot arrange to assist in the future.

Laboratory Experiments in Chemistry: to accompany Black and Conant's "Practical Chemistry." By N. Henry Black. Pp. x + 167. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1923.) 5*s.* net.

THE author of this small work can be congratulated upon having written a really practical text-book which is much superior to most of those now used in Great Britain. Its chief feature is absolute clarity of presentation; no pupil should go wrong if he follows faithfully the directions given, and if he tries to answer the numerous questions interpolated throughout the text he will exercise his intelligence as well as his fingers and his capacity for obeying instructions. Those who prefer the strictly heuristic method of teaching will probably not regard with favour a book of this kind, but they would find it very useful if—as is usually the case—they are expected to cover a lot of ground with a large class in a limited time. Other valuable features are the optional work given after each experiment, and, near the end of the course, some elementary lessons in applied chemistry. The present writer has given some of these experiments to his pupils and can testify to their value, not only in imparting knowledge but also in stimulating interest. Some minor points of criticism will doubtless suggest themselves to every teacher, but these are negligible in comparison with the excellence of the work as a whole. Unconscious humour, too, is not often to be found in a school text-book, but if the reader will refer to the second sentence on page 1 of this book and then glance at the illustrations on the frontispiece opposite, he will learn that the homely test-tube, beaker, crucible, etc., are among the "less familiar" pieces of apparatus. We wonder what are the more familiar pieces of apparatus in American schools?

Principles of Electric Motors and Control. By Gordon Fox. Pp. xiv + 499. (London: McGraw-Hill Publishing Co., Ltd., 1924.) 17*s.* 6*d.* net.

MOST books describing electric motors and controllers are written mainly from the point of view of the designer, that is, from the point of view of the manufacturer. The number of operating engineers, however, is much larger than the number of designers, and faulty application, as the author points out, can nullify good design. This book is intended for students and for those interested in the selection, application, purchase, and sale of electric motors and controllers. The discussions are simple and practical and will be easily understood by the engineer. Although many graphs are given, vector diagrams and higher mathematics have been rigorously excluded. The control diagrams all conform to standard American practice, but the practice in Great Britain is much the same. A very full bibliography is given.

The book will be found helpful both to the practical and theoretical electrical engineer. The latter will find in it diagrams which illustrate excellently practical applications of known theoretical principles with which he is familiar. For example, a clear diagram is given of the principal connexions for converting from one system of supply to another of different frequency at constant power.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Chimæras Dire: Transplantation of Heads of Insects.

WITH some astonishment I notice my friend, Dr. W. T. Calman, agreeing with the German authors Hans Blunck and Walter Speyer in his letter to NATURE of July 5, p. 11, entitled "Chimæras Dire," which is written with much sarcastic humour, but little knowledge of the subject. The title itself is misleading Walter Finkler has never claimed to have produced Chimæras in adult insects, a term signifying in biology "simultaneous development of parts compounded from tissues of different species (or races)"; he has merely studied the possibility of replantation of heads and described the results thereof. He has neither written that "The head of a herbivorous water-beetle persuaded a carnivorous body to be content with, and seemingly to digest, a vegetable diet," nor that "a Dytiscus strove to moderate the colourings of its wing-cases to suit the sober tastes of its new Hydrophilus brain." The only part of Finkler's work referring to nurture (*Archiv f. mikrosk. Anatomie u Entwickl.mechanik*, xcix., 1923, p. 113) alludes to the passage of coloured algæ through the re-established connexion between the cut ends of the œsophagus in *homoplastic* experiments on the replantation of Hydrophilus-heads, while the assumption of a darker hue after heteroplastic replantation of a Hydrophilus-head to a Dytiscus-body refers to the yellow crossbars of the thorax in the swimming beetle (pp. 127-128), a result Finkler ascribes to the influence of eyesight, but that can perhaps be more readily explained on the assumption of tyrosinase diffusing from the head to the thorax.

Dr. Calman's sentence, "a male head led a female body into unwonted perversities," will, I am afraid, also produce a wrong impression of Finkler's observations. Finkler's xenoplastic experiments on the exchange of heads between a male and a female Hydrophilus were conducted to see if the reproductive glands have any influence on the sexual instinct as displayed by the head in the antennal play of the male (and the several reflexes of the legs inspired by the œsophageal ganglions of the intact imago). The result was that no such influence could be detected (p. 124). The male head kept its usual reaction towards the female, and the female head did not acquire this character when transplanted to a body of opposite sex, quite in agreement with the many experiments on other insects, where removal or even heterological exchange of the reproductive glands in larvæ always failed to display any change in the secondary sexual characters of the imago.

As to the knowledge of Drs. Blunck and Speyer, "already known by a long series of anatomical and biological researches on the very water-beetles that were among the chief of Finkler's *corpora vilia*," of the physiology of these insects, I have just stated an example of it they have maintained that a Hydrophilus with Dytiscus-head could never live in water, because the former needs its feelers for respiration. Any one can easily convince himself of the fallacy of this belief, dating from an unlucky fabulation of Nitzsch (1811!) and repeated, it is true, in all treatises on the physiology of these beetles since his time. It is only necessary to amputate both antennæ of some Hydrophilus and keep the beetles as usual in water with some algæ. No inconvenience will befall them on account of this loss. I have a paper in the press on this subject for the *Zoologischen Anzeiger* which is to appear shortly, discussing the various criticisms of Finkler's experiments by several authors in Germany. I need not, therefore, go into further details now.

I should, however, like to add that Finkler has not "ignored requests to produce his chimæras, alive or dead, for investigation by others." His transplantations were produced alive at the meeting of the zoological section of the Zool. Bot Society of Vienna on November 11, 1921, for general inspection, and some dead specimens were handed on to Dr. Boulenger (has not Dr. Calman had the opportunity of seeing these himself as an "exhibit at a Royal Society soirée"?), the total preparations of the beetles, of which Finkler's Plate IV. gives but a poor impression, are in our Museum and hundreds have seen them. Wit is appropriate "in the pages of *Punch*"—but in the pages of NATURE we should try to keep to strict truth.

As to Mr. J. T. Cunningham's recent note (NATURE, July 26, p. 124) on "Transplantation of Heads of Insects," I am puzzled if it is meant as a joke or is the author really used to making his experiments on *five* individuals? (By the way, I am sure he cannot have read Finkler's paper, or he would have known that Finkler has attempted the transplantation of the *head alone* in the meal-worms without success.)

HANS PRZIBRAM.

The Vivarium,
Vienna II. Prater.

Radial Velocities and the Curvature of Space-time.

THE question of the reduction of the Doppler effect from the earth to the sun, or conversely, raised by Prof. Eddington in NATURE for May 24, is completely settled in my letter of May 10, which was published in NATURE for June 7, p. 818.

In his letter, however, Prof. Eddington mentions another point, the possible occurrence of an "imaginary star constant v_0" in

$$D^2 = r^2/R^2 + v_0^2/c^2, \quad . \quad . \quad . \quad (1a)$$

which requires an explanation.

The actual position is this. With some R-value, derived from previous material, a new object of estimated distance r may show an effect D smaller than r/R. Then (1a) calls for a negative v_0^2 or an imaginary v_0 What is the meaning of such a value? Simply, that the orbit *does not pass* through O, the sun, but ends at some perihelion distance $r_0 = R\sigma_0$, where the motion is reversed. Such radial motions are possible in de Sitter's world. Even then the analytical form (1a) may be retained, provided we remember that v_0^2/c^2 is to be replaced by $-\sigma_0^2$. In fact, by the equation of motion (NATURE, March 8)

$$\frac{R}{c}\frac{d\sigma}{dt} = \pm \cos\sigma\sqrt{1 - \cos^2\sigma/k^2} = \pm\frac{v}{c},$$

or by the original meaning of the constant, $k = \cos^2\sigma cdt/ds$, we have

$$k = \cos^2\sigma/\sqrt{\cos^2\sigma - v^2/c^2} = \text{const.}$$

If the star passes through the sun, $v = v_0$ for $\sigma = 0$, and $k = (1 - v_0^2/c^2)^{-\frac{1}{2}}$, and the formula

$$D = k[1 \pm \sqrt{1 - \cos^2\sigma/k^2}] - 1 \quad . \quad . \quad (1)$$

reduces approximately to (1a). But if it does not

The chapter on the colour of crinoids includes the stalked and sessile forms as well as the unstalked. The part ends with a section on the economic value of the recent crinoids; this is confined to their sale as curios, for, we are told, they serve no useful purpose; they are not even eaten by any animal that serves as human food. In this respect it is probable that the recent crinoids have acquired a securer footing than some of their large-bodied ancestors.

These two large books, though they contain only "introductory matter" to the systematic descriptions, already furnish a corpus of nearly every observation ever made on these beautiful creatures, and reference is facilitated by full tables of contents and indexes. Although a great deal of the work is based on Dr. Clark's own observations, especially concerning the skeletal and muscular anatomy, it does not profess to give new facts or original theories. That in no way lessens its great value to the worker, who will also find his wants attended to by various keys and by comparative diagrams. He will be grateful to Dr. Clark and will marvel at the energy and perseverance that have brought him so far along a laborious road.

F. A. B.

The Subject Index to Periodicals, 1917–1919. Issued by the Library Association. L: List of Periodicals Indexed and Author Index. Pp. ix+103. (London: Grafton and Co., 1924.) 21*s.* net.

THE alphabetical index of names of authors of articles included in the various Subject Indexes to Periodicals issued by the Library Association for the period 1917–1919 has now been published. The index contains more than 20,000 names of authors, with the sections of the Index and the headings under which the titles of their papers are registered. It is estimated that, on an average, each author has published two papers, so that the total number of papers indexed for 1917–19 will be about 40,000. Those who possess the valuable Subject Indexes already published will be able through this author index to find a paper when they have forgotten its title although they remember the author's name. The abbreviations for 477 periodicals used in preparing the indexes for 1917–19 are also given.

The headquarters of the "Subject Index to Periodicals" were transferred to the National Library of Wales, Aberystwyth, in January 1921. The access to periodicals in this Library has been of great assistance to the editors in preparing the indexes. The editors record the voluntary help they have had from some forty-eight libraries in Great Britain and from a number of private contributors. While expressing its grateful thanks to all who have helped in the undertaking since its beginning in 1915, the Library Association makes a strong appeal for assistance to those librarians who have hitherto held aloof from active co-operation in the work.

It is obvious that the value of the Index depends upon its completeness; although up to the present time some 575 periodicals have been examined, some of the libraries that have not yet taken part in the work may very well have on their shelves other periodicals containing relevant matter. We would urge any such libraries to consider whether they cannot arrange to assist in the future.

Laboratory Experiments in Chemistry: to accompany Black and Conant's "Practical Chemistry." By N. Henry Black. Pp. x+167. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1923.) 5*s.* net.

THE author of this small work can be congratulated upon having written a really practical text-book which is much superior to most of those now used in Great Britain. Its chief feature is absolute clarity of presentation; no pupil should go wrong if he follows faithfully the directions given, and if he tries to answer the numerous questions interpolated throughout the text he will exercise his intelligence as well as his fingers and his capacity for obeying instructions. Those who prefer the strictly heuristic method of teaching will probably not regard with favour a book of this kind, but they would find it very useful if—as is usually the case—they are expected to cover a lot of ground with a large class in a limited time. Other valuable features are the optional work given after each experiment, and, near the end of the course, some elementary lessons in applied chemistry. The present writer has given some of these experiments to his pupils and can testify to their value, not only in imparting knowledge but also in stimulating interest. Some minor points of criticism will doubtless suggest themselves to every teacher, but these are negligible in comparison with the excellence of the work as a whole. Unconscious humour, too, is not often to be found in a school text-book, but if the reader will refer to the second sentence on page 1 of this book and then glance at the illustrations on the frontispiece opposite, he will learn that the homely test-tube, beaker, crucible, etc., are among the "less familiar" pieces of apparatus. We wonder what are the more familiar pieces of apparatus in American schools?

Principles of Electric Motors and Control. By Gordon Fox. Pp. xiv+499. (London: McGraw-Hill Publishing Co., Ltd., 1924.) 17*s.* 6*d.* net.

MOST books describing electric motors and controllers are written mainly from the point of view of the designer, that is, from the point of view of the manufacturer. The number of operating engineers, however, is much larger than the number of designers, and faulty application, as the author points out, can nullify good design. This book is intended for students and for those interested in the selection, application, purchase, and sale of electric motors and controllers. The discussions are simple and practical and will be easily understood by the engineer. Although many graphs are given, vector diagrams and higher mathematics have been rigorously excluded. The control diagrams all conform to standard American practice, but the practice in Great Britain is much the same. A very full bibliography is given.

The book will be found helpful both to the practical and theoretical electrical engineer. The latter will find in it diagrams which illustrate excellently practical applications of known theoretical principles with which he is familiar. For example, a clear diagram is given of the principal connexions for converting from one system of supply to another of different frequency at constant power.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Chimæras Dire: Transplantation of Heads of Insects.

WITH some astonishment I notice my friend, Dr W. T. Calman, agreeing with the German authors Hans Blunck and Walter Speyer in his letter to NATURE of July 5, p. 11, entitled "Chimæras Dire," which is written with much sarcastic humour, but little knowledge of the subject. The title itself is misleading. Walter Finkler has never claimed to have produced Chimæras in adult insects, a term signifying in biology "simultaneous development of parts compounded from tissues of different species (or races)"; he has merely studied the possibility of replantation of heads and described the results thereof. He has neither written that "The head of a herbivorous water-beetle persuaded a carnivorous body to be content with, and seemingly to digest, a vegetable diet," nor that "a Dytiscus strove to moderate the colourings of its wing-cases to suit the sober tastes of its new Hydrophilus brain." The only part of Finkler's work referring to nurture (*Archiv f. mikrosk. Anatomie u. Entwickl.mechanik*, xcix., 1923, p. 113) alludes to the passage of coloured algæ through the re-established connexion between the cut ends of the œsophagus in *homoplastic* experiments on the replantation of Hydrophilus-heads, while the assumption of a darker hue after heteroplastic replantation of a Hydrophilus-head to a Dytiscus-body refers to the yellow crossbars of the thorax in the swimming beetle (pp. 127-128), a result Finkler ascribes to the influence of eyesight, but that can perhaps be more readily explained on the assumption of tyrosinase diffusing from the head to the thorax.

Dr. Calman's sentence, "a male head led a female body into unwonted perversities," will, I am afraid, also produce a wrong impression of Finkler's observations. Finkler's xenoplastic experiments on the exchange of heads between a male and a female Hydrophilus were conducted to see if the reproductive glands have any influence on the sexual instinct as displayed by the head in the antennal play of the male (and the several reflexes of the legs inspired by the œsophageal ganglions of the intact imago). The result was that no such influence could be detected (p. 124). The male head kept its usual reaction towards the female, and the female head did not acquire this character when transplanted to a body of opposite sex, quite in agreement with the many experiments on other insects, where removal or even heterological exchange of the reproductive glands in larvæ always failed to display any change in the secondary sexual characters of the imago.

As to the knowledge of Drs. Blunck and Speyer, "already known by a long series of anatomical and biological researches on the very water-beetles that were among the chief of Finkler's *corpora vilia*," of the physiology of these insects, I have just stated an example of it: they have maintained that a Hydrophilus with Dytiscus-head could never live in water, because the former needs its feelers for respiration. Any one can easily convince himself of the fallacy of this belief, dating from an unlucky fabulation of Nitzsch (1811!) and repeated, it is true, in all treatises on the physiology of these beetles since his time. It is only necessary to amputate both antennæ of some Hydrophilus and keep the beetles as usual in water with some algæ. No inconvenience will befall them on account of this loss. I have a paper in the press on this subject for the *Zoologischen Anzeiger* which is to appear shortly, discussing the various criticisms of Finkler's experiments by several authors in Germany. I need not, therefore, go into further details now.

I should, however, like to add that Finkler has not "ignored requests to produce his chimæras, alive or dead, for investigation by others." His transplantations were produced alive at the meeting of the zoological section of the Zool. Bot. Society of Vienna on November 11, 1921, for general inspection, and some dead specimens were handed on to Dr. Boulenger (has not Dr. Calman had the opportunity of seeing these himself as an "exhibit at a Royal Society soirée"?), the total preparations of the beetles, of which Finkler's Plate IV. gives but a poor impression, are in our Museum and hundreds have seen them. Wit is appropriate "in the pages of *Punch*"—but in the pages of NATURE we should try to keep to strict truth

As to Mr. J T. Cunningham's recent note (NATURE, July 26, p. 124) on "Transplantation of Heads of Insects," I am puzzled if it is meant as a joke or is the author really used to making his experiments on *five* individuals? (By the way, I am sure he cannot have read Finkler's paper, or he would have known that Finkler has attempted the transplantation of the *head alone* in the meal-worms without success.)

HANS PRZIBRAM.

The Vivarium,
Vienna II. Prater

Radial Velocities and the Curvature of Space-time.

THE question of the reduction of the Doppler effect from the earth to the sun, or conversely, raised by Prof. Eddington in NATURE for May 24, is completely settled in my letter of May 10, which was published in NATURE for June 7, p. 818.

In his letter, however, Prof. Eddington mentions another point, the possible occurrence of an "imaginary star constant v_0" in

$$D^2 = r^2/R^2 + v_0^2/c^2, \quad . \quad . \quad . \quad (1a)$$

which requires an explanation

The actual position is this. With some R-value, derived from previous material, a new object of estimated distance r may show an effect $|D|$ smaller than r/R. Then (1a) calls for a negative v_0^2 or an imaginary v_0. What is the meaning of such a value? Simply, that the orbit *does not pass* through O, the sun, but ends at some perihelion distance $r_0 = R\sigma_0$, where the motion is reversed. Such radial motions are possible in de Sitter's world. Even then the analytical form (1a) may be retained, provided we remember that v_0^2/c^2 is to be replaced by $-\sigma_0^2$. In fact, by the equation of motion (NATURE, March 8)

$$\frac{R}{c}\frac{d\sigma}{dt} = \pm \cos\sigma\sqrt{1-\cos^2\sigma/k^2} = \pm\frac{v}{c},$$

or by the original meaning of the constant, $k = \cos^2\sigma cdt/ds$, we have

$$k = \cos^2\sigma/\sqrt{\cos^2\sigma - v^2/c^2} = \text{const.}$$

If the star passes through the sun, $v = v_0$ for $\sigma = 0$, and $k = (1 - v_0^2/c^2)^{-\frac{1}{2}}$, and the formula

$$D = k[1 \pm \sqrt{1-\cos^2\sigma/k^2}] - 1 \quad . \quad . \quad (1)$$

reduces approximately to (1a). But if it does not

pass through the sun, we have $v=0$ for $r=r_0$, so that $k=\cos\sigma_0$, and (1) becomes, for small σ_0, σ,

$$D^2=\sigma^2-\sigma_0^2=\frac{1}{R^2}(r^2-r_0^2). \quad . \quad . \quad (1b)$$

If the object, no matter how distant, just passes through its "perihelion" or nearly so, we have a nil-effect or a small effect. Such cases may be rare (as *e.g.* that of N.G.C. 6626), but are possible and well provided for by the general formula (1). This removes every difficulty. At the same time we see that, in a correlation graph, the observed points r, $|D|$ need not lie all above a certain line, but may as well fall below it. They should only show a tendency of crowding along it, on either side, gathering pre-eminently, but not exclusively, in the first and the third quadrants (NATURE, June 7, p. 819, Fig. 1). Such a tendency is shown, by the points thus far available, markedly enough. These relations and formula (1*b*), a supplement to (1*a*), are discussed in my second *Phil. Mag.* paper now in the press. There also the desirable extension of the formula from radial to *any* inertial motions is given. If $r_0=R\sigma_0$ and $v_0=c\beta_0$ be the distance at and the velocity of passage through the perihelion, the result is, rigorously,

$$D=\frac{\cos^2\sigma/k}{1\mp\sqrt{1-\frac{\cos^2\sigma}{k^2}\left(1+\frac{p^2}{R^2\sin^2\sigma}\right)}}-1, \qquad (2)$$

where

$$k=\cos^2\sigma_0/\sqrt{\cos^2\sigma_0-\beta_0^2}, \quad p=R\beta_0\sin\sigma_0/\sqrt{\cos^2\sigma_0-\beta_0^2},$$

and approximately, to all purposes,

$$D^2=\left(1-\frac{r_0^2}{r^2}\right)(\sigma^2+\beta_0^2), \quad . \quad . \quad (2a)$$

of which (1*a*), (1*b*) are but obvious special cases. The statistical formula, (2) (NATURE, June 7, p. 818), now becomes $R^2=\frac{2}{3}(\overline{r_1^2}-\overline{r_2^2}):(\overline{D_1^2}-\overline{D_2^2})$, and, when applied to all thirteen objects there tabulated, gives $R=7\cdot2\times10^{12}$ astr. units. Details are given in the last-mentioned paper.

LUDWIK SILBERSTEIN.

Rochester, N.Y., July 5.

Growth-rings of Herring Scales.

WHILE engaged upon work on herring scales at the Ministry of Fisheries' Laboratory at Lowestoft in 1922 and 1923, I made several discoveries regarding the so-called "winter rings," and the comparative growth-rates of scale and fish. These discoveries appeared to me to be of sufficient importance to be brought forward for discussion at a meeting of the Herring Committee of the International Council held at Edinburgh in June 1923, at which I offered a theory of age-determination alternative to the Norwegian theory.

At a later meeting held at Christiania in June 1923, the Herring Committee rejected my theory and adopted the Norwegian theory as a working hypothesis. To this resolution I was a subscriber with some misgivings. In the light of further research, however, I am compelled to revert to my former position, and, while, in accordance with the resolution of the Herring Committee, the Norwegian theory is accepted by the Ministry of Fisheries as a working hypothesis, it has been thought desirable that I should be given an opportunity to state publicly the main facts on which my theory is based, since these have not yet been published. They are as follows:

(1) While in the case of young herrings the number of "winter rings" is the same on all normally developed scales, in the case of older fish there is considerable variation in their number. The greatest numbers appear on the large scales from the forepart of the body (position A), which are used by the Norwegians for age-estimation, while the smallest numbers of clear and easily-read rings appear on scales from near the edge of the dark dorsal pigment and below the posterior end of the dorsal fin (position B). Photos, Fig. 1 and Fig. 2, are of scales from an English fish of 27 cm. in length, landed at Lowestoft; Fig. 1 is from position A and Fig. 2 from position B.

(2) The proportionate growth-rates of scale and fish are similar on scales from regions A and B in the case of small herrings, but increasingly dissimilar as larger and larger fish are taken. Thus, in large fish of which the scales from position A are very ringy (usually known as "old" fish), either these ringy scales have grown disproportionately fast or the scales from position B disproportionately slowly in the later life of the fish. That the differences in

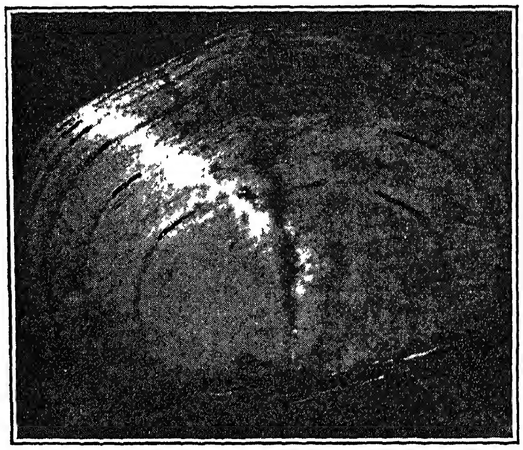


FIG. 1.—Showing six rings traceable all round the striated portion.

the "calculated growth" are significant is obvious from the following examples:

				Calculated Growth.	
			Scale from Position	(A).	(B).
(1)	Shields fish .	37 cm.	1st year	10·5	12·6
			2nd ,,	20·3	23·6
			3rd ,,	27·2	30·4
(2)	Norwegian .	34 cm.	1st ,,	8·0	9·8
			2nd ,,	15·1	16·9
			3rd ,,	22·6	25·5
(3)	Norwegian .	34 cm.	1st ,,	6·7	8
			2nd ,,	12·1	14·1
			3rd ,,	21·3	23·8
(4)	Norwegian .	34 cm.	1st ,,	6·4	8·8
			2nd ,,	11·0	13·6
			3rd ,,	13·8	17·1

This discrepancy in calculated growth is due to difference of growth-rate taking place mainly in the later part of the herring's life, as may be seen by assuming any length, say 15 cm., for the length of the fish (say No. 4) at the formation of the 3rd ring, and calculating the two first years' growths from the two scales, giving

	Scale A.	Scale B.
1st year . .	7·1	7·7
2nd ,, . .	12·0	12·0

This is very significant, considered in relation to the so-called "phenomenon of decrease of calculated growth-rate with age," which is ascribed by the Norwegians to the influence of migration, the largest fish of each year-class joining any shoal of larger fish first.

(3) The groupings of rings on the outer part of the scale of large herrings. In a large number of cases of ringy scales there is a tendency for the "winter rings" to get closer and closer as we go from the centre of the scale, until they become very crowded at a certain point; after which they widen out, again get closer and closer, and again become crowded. Fig. 3 exemplifies this phenomenon. If the rings are read in groups, instead of singly, an

FIG. 2.—Showing only four rings traceable all round the striated portion.

estimate of age is arrived at, differing widely from that based on reading of single rings—in the present case 5 years instead of at least 14 years, the inner group under a high power being seen to consist of about 5 rings, and the outer of about 6 rings, and the three rings inside these two groups being read singly, as the sub-surface phenomena occurring inside these rings would not be considered as "annual rings" by any scale-readers.

(4) The existence of rings in the outer part of the

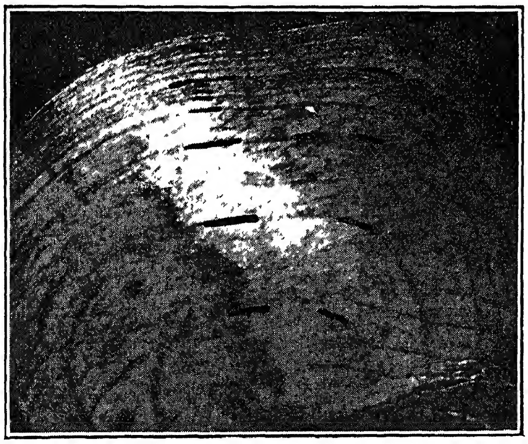


FIG. 3.—Showing three single rings and two groups of rings.

scale having stronger optical value than neighbouring rings, but similar optical value to the first 3 or 4 winter rings. These strong or "α" rings can often be traced out into the exposed part of the scale. If only these "α" rings are recognised as winter rings the age-estimate is of course lower than in the reverse case.

The above phenomena form the main basis of my disagreement with the Norwegian theory. To mention further evidence for my views or to describe my alternative theory would extend this beyond the bounds of a letter, but such evidence exists and will be laid before any workers interested in the matter. The scales from which the photos, here reproduced (Figs. 1-3), were taken, and many others, are also open to inspection.

H. J. BUCHANAN-WOLLASTON.
Ministry of Agriculture and Fisheries,
Fisheries Laboratory,
Lowestoft, July 17.

The Band Spectrum of Boron Monoxide.

IN two recent letters to NATURE (May 24 and 31) Mr. W. Jevons has questioned the adequacy of my evidence as to the oxide origin of a band spectrum which he had previously ascribed to boron nitride.[1] In his second letter he reports that these bands are absent from the spectrum of the discharge through a mixture of BCl_3 and O_2, although the ordinary boric oxide bands are present. This he considers convincing evidence against BO as the emitter of the bands in question. In view, however, of evidence outlined below, a full account of which will appear probably in the *Physical Review*, there seems little room for doubt that the bands are really due to BO and not to BN. The other oxide bands may then be ascribed, as in the past, and in accordance with their complex character, to B_2O_3.

When generated by the reaction of BCl_3 with active nitrogen, the intensity of the BO bands shows a maximum when perhaps 0·5 per cent. of oxygen is present. If the nitrogen is purified beyond this point, using phosphorus, its degree of activation, as gauged by the intensity of the α bands of the afterglow, is increased markedly, finally approaching asymptotically an upper limit. Unlike the BO bands, the SiN bands, obtained by using $SiCl_4$ instead of BCl_3, are stronger the less oxygen is present, and are practically extinguished by the amount of oxygen most favourable for BO. These facts appear to disprove Mr. Jevons's suggestion that the weakening of the BO bands in very pure nitrogen is due to a decrease in its activity when the oxygen is all removed. Probably, if this stage of purification was approached, phosphorus vapour replaced oxygen as a catalyst.

When the BO bands are at their strongest, the yellow of the α bands and the blue of the β bands of active nitrogen are roughly equal in intensity. Lord Rayleigh has shown[2] that the β (and γ) bands are due to the presence of oxygen, probably as NO. Prof. R. T. Birge has concluded[3] that the α bands are emitted by (metastable) excited N_2 molecules; also (private communication) that the β and γ bands are due to NO.[4] The formation of the emitters of the BO bands may then proceed somewhat as follows, denoting an electronically excited molecule by an accent ($'$):

(1) $BCl_3 + N_2' \rightarrow BN + NCl_3$. (2) $BN + NO' \rightarrow BO' + N_2$.

Or, the formation of BO$'$ may be more direct; in any case, some BN is probably also formed,[1] but apparently gives no spectrum.

In repeating Mr. Jevons's recent experiments, I have found the B_2O_3 bands best brought out with a very large excess of oxygen over BCl_3. Under these conditions the ratio of excited BO to excited B_2O_3 molecules present and emitting at any moment may well be negligibly small, in view of the chemically highly unsaturated character of BO. In active nitrogen,

[1] W. Jevons, Roy. Soc. Proc. A, 91, 120-34 (1915).
[2] Roy. Soc. Proc. A, 93, 254 (1917).
[3] *Phys. Rev.*, 23, 295 (1924).
[4] E. P. Lewis (*Astrophys. Journ.*, 20, 49, and 58 (1904)) has shown that the γ bands are, without much doubt, due to NO; and Birge finds that the β and γ bands have a common final state. Also, their simple structure indicates a diatomic emitter.

however, consisting of a small proportion of N_2' and NO' molecules in a medium chiefly of unexcited and so inert nitrogen, and with no continuous exciting discharge, this ratio may well be reversed, especially in view of the probable mode of formation of BO'.

In some experiments with a carbon arc,[5] the anode of which contained BN, B_6C, or B_2O_3, I have found that in all three cases the BO (and the B_2O_3) bands appear, in moderate intensity, when an atmosphere of oxygen or air is used, but that they are completely absent in nitrogen. In the latter case BN is doubtless formed, but does not emit a spectrum. No doubt B_2O_3 is partly dissociated into BO at the high temperature of the arc. In the lower temperature of the flame only the B_2O_3 bands are known to occur.

The final piece of evidence is the very close agreement of the vibrational isotope effect with theory for BO, and its definite disagreement for BN. In view of the strength of the theory, this by itself makes BO very probable. If the bands were due to BN, the agreement of experiment with theory would become qualitative only; and if this were the case, the chance is very small that the deviation of the theory from quantitative correctness would be just such as to correspond to an exact but illusory quantitative agreement for BO. The following empirical equations represent within experimental error the positions of all the measurable BO band heads:[6]

$$\begin{array}{llllll}
B^{10}O: & \nu_\alpha = \left\{\begin{matrix} 23652{\cdot}2\,;\ 23638{\cdot}9\,; \\ 23526{\cdot}0\,;\ 23512{\cdot}7 \end{matrix}\right\} & +1285{\cdot}6n' & -11{\cdot}7n'^2 & -1926{\cdot}8n & +12{\cdot}21n^2 \\
B^{11}O: & \nu_\alpha = \left\{\begin{matrix} 23661{\cdot}6\,;\ 23648{\cdot}3\,; \\ 23535{\cdot}4\,;\ 23522{\cdot}1 \end{matrix}\right\} & +1247{\cdot}9n' & -10{\cdot}6n'^2 & -1873{\cdot}2n & +11{\cdot}68n^2 \\
\text{Ratio}: & (\textit{Difference} = -9{\cdot}4) & 1{\cdot}0302 & 1{\cdot}104 & 1{\cdot}0286 & 1{\cdot}045 \\
B^{10}O: & \nu_\beta = 42874{\cdot}6 - 0{\cdot}19nn' & +1304{\cdot}6n' & -10{\cdot}43n'^2 & -1927{\cdot}9n & +12{\cdot}66n^2 \\
B^{11}O: & \nu_\beta = 42880{\cdot}9 - 0{\cdot}17nn' & +1268{\cdot}8n' & -9{\cdot}98n'^2 & -1872{\cdot}9n & +11{\cdot}84n^2 \\
\text{Ratio}: & (\textit{Difference} = -6{\cdot}3) & 1{\cdot}0282 & 1{\cdot}045 & 1{\cdot}0294 & 1{\cdot}069
\end{array}$$

For the coefficients of the linear terms, the theoretical ratio is 1·0292 for BO and 1·0276 for BN; for the quadratic terms, 1·0593 for BO and 1·0560 for BN. The mean of the four experimental values is $1{\cdot}0291 \pm 0{\cdot}0004$ for the former, $1{\cdot}066 \pm 0{\cdot}010$ for the latter.—The coefficients of n and n^2 indicate a common final state for the α and β systems.

A remarkable feature of the BO bands is the non-coincidence, for the bands having the vibrational quantum numbers n and n' both zero, of corresponding heads of the two isotopes. For the centres of these bands an approximate correction, based on measurements of band structure, increases the differences recorded above to $-10{\cdot}0$ and $-7{\cdot}2$ for the α and β systems respectively. According to the theory as now accepted, these corrected differences must represent electronic isotope effects, of much greater magnitude than have been found in line spectra. Since this is highly improbable, the following alternative explanation is decidedly to be preferred. If one assumes that the true values of the vibrational quantum numbers are not n and n', but each $\frac{1}{2}$ unit greater, the apparent isotope effect for the true vibrational zero point is reduced to $-2{\cdot}2$ for the α and $+2{\cdot}4$ for the β system. These differences are now small enough to have resulted from inaccuracies in the determination of equation coefficients. It is then probable that the minimum vibrational energy of BO (and doubtless of other) molecules is $\frac{1}{2}$ quantum. In the case of molecular rotational energy, the necessity of using half quanta is already well established. Analogous relations appear in line spectra; *e.g.* Heisenberg[7] has successfully used half-integral radial and azimuthal quantum numbers in explaining the structure and Zeeman effect of doublets and triplets.

ROBERT S. MULLIKEN,
National Research Fellow.
Jefferson Physical Laboratory,
Harvard University, Cambridge, Mass.

[5] Similar experiments by Jevons (*l.c.*) on a boron arc were inconclusive, although favouring the nitride origin of the BO bands.

[6] It can be shown that no appreciable error is introduced here in the isotope ratios by using data on heads. The nn' terms are due to the fact that the data are for heads.

[7] W. Heisenberg, *Zeit. für Physik*, 8, 273 (1922).

Effect of Length of Day on Flowering and Growth.

AN attempt has been made to confirm the work of Garner and Allard[1] done in America, under the conditions prevailing in Britain at the Welsh Plant Breeding Station, and to test particularly the behaviour of various strains of herbage plants under different lengths of day.

The plants, equal propagants, or pure line plants, were grown in pots or boxes placed on trucks which were run in and out of a three-sectioned hut so that they received 12, 9, and 6 hours' daylight. Control plants received the full natural daylight. Equal soil, water, and temperature conditions were provided so far as possible.

The results obtained fall into three divisions, namely:

I. EVER-BLOOMING TYPE.—Plants of *Poa Annua* flowered normally under all light periods.

FIG. 1.—American Red Clover, photographed on July 29, showing, left to right, control (many heads ripening), 12-hour plant (with small flowers), 9-hour plant (almost prostrate, with a few small heads), and 6-hour plant (prostrate, in winter habit).

II. SHORT-DAY PLANTS.—*Chrysanthemums* (var. Mrs. William Buckingham): Subjected to treatment on May 9. Short-day plants, flower buds July 26, open in early August. Controls, no buds August 12. *Phaseolus vulgaris* (Runner Bean, Sutton's "Best of All"): Treated plants were small and bushy, with thick nodes and swollen roots. Height of control plants 50 in., height of 6-hour plants 9 in. Treated plants flowered 4 days earlier than control plants.

III. LONG-DAY PLANTS.—(1) *Broad Red Clover* (ex. Suffolk): Control plants started flowering May 21, attained flowering zenith June 6; 12-hour plants started flowering June 28, attained flowering zenith July 26; 9-hour plants started flowering July 6, attained flowering zenith July 31; 6-hour plants have remained entirely in the winter habit. (2) *Montgomery Variety*: Controls flowered freely from July 16, reaching their flowering zenith about July 26. The 12-, 9-, and 6-hour plants were quite prostrate and in the winter habit on August 10.

[1] "Effect of Relative Length of Day and Night and other Factors of the Environment on Growth and Reproduction in Plants," W. W. Garner and H. A. Allard (*Journ. Agric. Res.*, vol xviii. No. 11, p. 553); "Further Studies in Photoperiodism, the Response of the Plant to Relative Length of Day and Night," W. W. Garner and H. A. Allard (*Journ. Agric. Res.*, vol. xxiii. No. 11, p. 71, 1923); "Photoperiodism in Relation to Hydrogen ion Concentration of Cell Sap and Carbohydrate Content of the Plant," W. W. Garner, C. Bacon, and H. A. Allard (*Journ. Agric. Res.*, vol. xxvii. No. 3, p. 119, 1924).

Cocksfoot.—Some of the Cocksfoot results can be summarised thus:

	First Panicle emerging.	Full Flowering (Pollen).	Ht. on 31/7.
"French Hay" strain:			
Control plants	19/5	5/6	34 in. ripe seed.
12-hour plants	6/6	16/6	15 in. ripening.
9-hour plants, 6-hour plants	Remained in winter habit, good leafy growth, no signs of panicles at all, 6/8/24.		5 in.
"Tussocks" type:			
Control plants	29/5	25/6	27 in. ripening.
12-hour plants	30/6	29/7	9 in. full flowering just over.
9-hour plants, 6-hour plants	Plants as yet in winter habit, 6/8/24.		

Briefly, the following have proved to be "long-day" plants:

Grasses.—Sweet Vernal, "Late" and "Early Broad Leaf" strains; Meadow Foxtail, "Late Pasture" strain, "Early Hay" strain; Cocksfoot

FIG. 2.—Montgomery Red Clover, photographed on August 2, showing, left to right, 9- and 12-hour plants quite prostrate in winter habit and control plant flowering.

strains, "French Hay," "Danish Open," "Late Indigenous," and "Tussocks"; Perennial Rye Grass, Early and late strains; Timothy, Early strains. *Red Clover.*—Broad Red, American Medium, and Montgomery. *Oats.*—Grey Winter, Record, Orion, Ceirch du Bach. *Radish.*—Scarlet Globe. *Foxglove.*

A more detailed account will appear shortly elsewhere. Thanks are due to Prof. R. G. Stapledon, who arranged for the necessary equipment and provided facilities for conducting the work, and to Mr. J. W. Watkins, Superintendent of the Welsh Plant Breeding Station Gardens, for careful attention to cultural detail.

M. A. H. TINCKER.

Agricultural Buildings,
University College of Wales,
Aberystwyth.

The Insect Fauna of an Indian Island.

IT has been my good fortune to be associated with the late Dr. N. Annandale in the study of the fauna of a small island in the Chilka Lake, Orissa—the first work of its kind in India. This study has, I believe, a general interest, and I need scarcely apologise for presenting this brief analysis of the insect fauna of this island.

The physical features of Barkuda Island form the subject of a memoir by Annandale (1922), but it may be recapitulated here that the island is situated in the Chilka Lake on the east coast of India in lat. 19° 38′ N. long. 85° 12′ E., and lies in the extreme north-western corner of the Madras Presidency. In outline it forms a right-angled triangle, its longest side being about three-quarters of a mile long, and its shortest less than half as much: the total area equals about half a square mile. It is composed of stratified rocks covered in the interior with a thin layer of red soil, its geological nature, combined with a low average rainfall (as compared with that of the mainland), being responsible for the sclerophytic nature of its vegetation, a distinctive feature of which is the fig-jungles in which there is a dense undergrowth composed mainly of the shrub *Glycosmis pentaphylla.* The dominant tree in these ficetii is the Banyan (*Ficus bengalensis*), the decayed trunks of which are largely inhabited by termites. In inland areas where there is no ficetum, *Weihea ceylonica* is the dominant shrub, and the fig-trees are replaced by the Nim (*Barringtonia acutangula*) and *Craeteva religiosa.* The island is almost completely surrounded by a marginal zone of the trees of *Pongamia glabra.* Other common plants are the Euphorbias (*E. neriifolia* and *Opuntia* sp.), the Custard-apple (*Anona squamosa*), and the herbs *Crotolaria striata, Tephrosia purpurea,* and

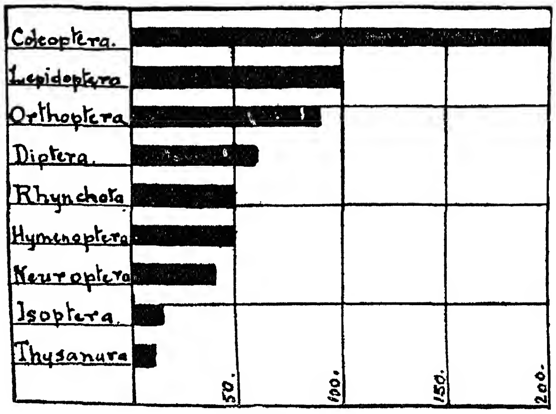


FIG. 1.

Jatropha gossypifolia. Barkuda is separated from the mainland of the western shore of the lake by a channel only a mile broad, and is thus not out of the range of insect immigrants, even those of comparatively feeble flight.

Dr. Annandale's main object in studying the fauna of the island was that it provided an easy means of ascertaining the faunal and floral constituents of a limited area in the tropics, of a somewhat commonplace nature, and the results provide an interesting comparison with the biological features of other areas in the East. It was found that the species of insects inhabiting the island exhibited no morphological peculiarities in response to an unfavourable environment, but were for the most part common and widely distributed species able to exist on the island by reason of their physiological "hardness," or because they could adapt themselves to feed on strange and not very delectable food-plants. It would seem that a rich flora tends to produce a large and varied number of insect forms with a comparative scarcity of individuals, while the insect fauna of such areas as Barkuda are poor in species but rich in individuals.

In the accompanying diagram (Fig. 1), I have attempted to indicate (relatively) the approximate number of forms of the various orders (used in the old sense, *e.g.* Neuroptera to include Odonata, etc.) found on the island. It must be remembered that the totals include regular visitors and stray immigrants to the island. Geographically it seems to be part of the frontier between the faunas of the central and southern districts of the Indian peninsula. *Per exemplum* Barkuda appears to represent the extreme north-eastern limit in India of the dis-

tribution of the Pierid butterfly *Colotis calais amatus*. The South Indian element is strongly noticeable in its insect fauna. In the diagram, the total for "Hymenoptera" includes only the Aculeates; three-quarters of the neuropteroid insects are dragon-flies.

In the space at my disposal it is not possible to consider any special characteristics within the various orders. I may mention, however, that much taxonomic and bionomic information has been accumulated (especially with reference to the termites), and the reader is referred to the various reports on the fauna of the island. A considerable number of new forms have also been described, including such interesting insects as the hemipterous termitophile *Termitaphis annandalei* Silvestri. At some future date a complete summary may be provided.

See Rec. Ind. Mus., xxii, pp. 313-421, 1921; xxiv, pp. 289-311, 1922; xxv, pp. 221-263, 1923; xxvi, pp. 165-191, 1924 (various authors). Also Annandale, Mem. As. Soc. Bengal, vii, p. 257, 1922.

CEDRIC DOVER.

London, July 25.

On the Spectrum of Ionised Potassium in Connexion with the Red and Blue Spectrum of Argon.

BY Zeeman and Dik (Proc. Amsterdam 25, 67, 1922), and Dik and Zeeman (Proc. Amsterdam 26, 500, 1923), it was found that in the electrodeless discharge (observations of McLennan, Dik and Zeeman) most of the lines of ionised potassium between 6594 Å and 3063 Å could be arranged in quadruplets.

If the frequency of the first line of each quadruplet is designated P, and the succeeding ones Q, R, S, it was found that

$$Q=P+847$$
$$R=P+1695$$
$$S=P+2542.$$

For the red spectrum of argon, exhibited under the uncondensed discharge, and for λ below 4704 Å, Rydberg, in 1897, found a similar regularity. Paulson extended those results, and Meggers increased their accuracy. The frequency relations for the red argon spectrum are, with similar notations:

$$B=A+846\cdot1$$
$$C=A+1649\cdot3$$
$$D=A+2256\cdot1$$

In both cases some of the "quadruplets" are incomplete. It is certainly remarkable that the number 847 occurs in both spectra.

We have extended the former investigation and have included an analysis of the "blue spectrum" of argon developed by the condensed discharge.

The following table contains the new results, together with those formerly given.

Argon, Red Spectrum (Rydberg).	Argon, Blue Spectrum.	Ionised Potassium.
A	p	P
B=A+ 846	$q=p+845$	Q=P+ 847
C=A+1649·3	$r=p+1695$	R=P+1695
D=A+2256·1		S=P+2542
	t	T
(411,57)	$u=t+414$	U=T+ 413

From this table it appears that the connexion between the spectra of ionised potassium and argon (blue) is closer than that between the spectra of ionised potassium and argon (red). We find the numbers 414, 845, 1695 characteristic for the blue spectrum of argon. The number 847 or thereabout occurs with red argon, blue argon, and ionised potassium; moreover, 1695 links blue argon to ionised potassium.

Then there is the number 414, which occurs, as we find, in numerous doublets of ionised potassium and argon (blue). It may be mentioned that Rydberg directed attention to the occurrence of the number 411·57 in the red spectrum of argon.

That there is a close numerical connexion between the three spectra considered seems proved, but the physical interpretation of the characteristic numbers is quite unknown.

Tables and calculations will be published elsewhere.

T. L. DE BRUIN.
P. ZEEMAN.

Amsterdam, August 15.

Anomalous Adsorption.

BILTZ and Steiner (*Kolloid-Zeitschrift*, 1910, 7, 113) have described several cases of so-called "anomalous adsorption," for example, the adsorption of Night Blue and Victoria Blue B. by cotton and charcoal. The adsorption isotherms rise to a maximum and fall off again with increasing concentration of the dyestuff. Hatschek in his "Physics and Chemistry of Colloids," 1922, p. 146, suggests that electrical factors may complicate adsorption "though these do not very readily account for the maximum." During a study of the dyeing of wool by Night Blue I have obtained adsorption curves of the same peaked form, using the same colorimetric method of estimation as Biltz and Steiner. On examining the dyed wool, however, it could not be said that the colour was any lighter in the case of the more concentrated solutions, and some defect was therefore sought in the method of experiment.

It had been noticed that the dyestuff solutions remaining after adsorption on the wool had a greenish-blue colour when viewed by transmitted light in the colorimeter, whereas the original Night Blue solutions were a pure blue; this gave the clue to the defect. Although Night Blue solutions appear to contain no free chlorine ions, the solutions remaining after adsorption were both acid and contained chlorine ions. Hydrochloric acid is probably produced during adsorption, and this has been shown to have a profound influence on the colour of Night Blue solutions. 1, 2, 3, and 4 c.c. of a very dilute hydrochloric acid solution were added to the same amounts of dyestuff solution and made up to the same volume with distilled water. These solutions were compared colorimetrically with a standard Night Blue solution of the same concentration but containing no acid. If we denote the concentration of the standard by unity, the *apparent* concentrations of the acid solutions in order were found to be 1·28, 1·50, 1·83, and 2·11. Furthermore, they showed the same greenish-blue colour noticed previously. In the adsorption of Night Blue by wool the amount of acid liberated will increase with the amount of dye adsorbed, but in consequence of this acid the apparent amount of dyestuff unabsorbed, estimated colorimetrically, will be increased. Since the amount of dye adsorbed is estimated by difference (original concentration known) the explanation of the peaked adsorption isotherms is self-evident, and "anomalous adsorption," as described by Biltz and Steiner, has probably no real existence. The determination of the true adsorption curve is in progress.

JOHN B. SPEAKMAN.

The University, Leeds.

Species and Chromosomes.[1]

By Prof. R. Ruggles Gates.

It is only since the beginning of the present century that the progress of biology has rendered possible the discussion of this topic. When the "Origin of Species" was written, chromosomes were unknown, and the study of nuclear division and the relation of chromosomes to the life cycle only began in the 'seventies and 'eighties of the last century. The names of Flemming, Strasburger, Boveri, and many others are connected with the early work on chromosomes, when alcoholic fixation and methods of sectioning first made possible their study. Flemming in 1882 first concluded that 24 chromosomes was probably a constant number in the nuclear divisions of the cells of the Salamander. In the following year van Beneden discovered, in Ascaris, that the egg and sperm contained half as many chromosomes as the somatic cells. From that time to this the process of chromosome reduction has been studied with increasing intensity. Its general relation to the life cycle is now known in nearly all the larger groups of plants and animals.

Until the end of the nineteenth century the study of cell structure developed quite independently of views regarding heredity and evolution, although it had often been suggested that the chromosomes formed the basis of heredity, and that they consisted of differentiated portions or elements. The rediscovery of Mendel's law in 1900 was the beginning of a remarkable convergence between two independent disciplines, the microscopic study of cells and chromosomes on one hand, and the observational and experimental study of heredity and evolution on the other. There is no more striking instance than this, of the convergence of two independent lines of investigation, in the whole history of biology.

It is equally significant that the advances in our knowledge of chromosomes have been alternately based upon studies of plants and animals, sometimes one and sometimes the other being the basis of a particular new line of advance. Whichever has taken the first step in a particular new line of departure, it has usually found confirmation from the other. Even sex chromosomes, which were first discovered in insects and were most intensively investigated in that group, are now known to occur not only in mammals, including man, but also in certain Liverworts and in certain diœcious flowering plants. Nothing so strikingly proclaims the unity of the organic world as the profound similarity which has been shown to exist in the fundamental cellular processes of the two kingdoms.

Moore had discovered synapsis, or the contracted phase of the nuclei preceding the reduction divisions, in Elasmobranch fishes, in 1896. It was believed that a pairing of elements took place at this period of maturation. In 1901 Montgomery suggested that synapsis consisted in a conjugation of homologous maternal and paternal chromosomes before their separation in the reduction division. Guyer (1900), in a study of spermatogenesis in pure and hybrid pigeons, had already pointed out that the separation of the pairs of chromosomes would account for cases of reversion in hybrids. In short, the chromosome mechanism was recognised as furnishing a basis for what we now call Mendelian behaviour at the same time that Mendel's laws were made known. A similar suggestion was made by Cannon (1903) in a brief study of the reduction divisions in hybrid peas.

Sutton in 1903 produced definite evidence of the pairing of homologous chromosomes of different sizes and shapes in the grasshopper Brachystola. In 1905 Strasburger showed the same arrangement of homologous chromosome pairs in plants, and in the same year Farmer and Moore suggested the term "meiosis" for the whole process of chromosome reduction.

For the original recognition of the individuality, or to use Wilson's term, the genetic continuity of chromosomes, we are largely indebted to Boveri, although the general acceptance of this view has resulted from an enormous amount of later detailed evidence. Among this evidence an important place is occupied by the work on hybrids, including that of Rosenberg (1904) on a species hybrid of Drosera, of Moenkhaus (1904) on hybrid fishes, and of Doncaster, Gray, Tennant, and others on generic hybrids of echinoderms, as well as the more recent experiments of Federley on species hybrids of the moth Pygæra. In all such cases the parental chromosomes maintain their characteristic differences of form and behaviour in the hybrid. These and a host of other results show that the chromosomes are not only self-perpetuating entities, through longitudinal division, but that they are also self-determining as regards their form, and we may now add as regards the finer elements of their structure.

In the last fifteen years particularly, the alliance between cytology and genetics in the experimental study of heredity and variation has become increasingly intimate. Beginning with the recognition of chromosome segregation in meiosis as the basis of Mendel's law of heredity, this was soon followed by the discovery (1906) of definite relations between chromosome numbers and mutations in Œnothera. Since 1910 Morgan and his colleagues have built up a combined system of genetical and cytological results in Drosophila which is unequalled in any other organism. Their theory of linkage and crossing-over has brought the phenomena of meiosis, chromosome structure, and heredity into still closer relationship. More recently Blakeslee and Belling have discovered chromosome relationships in Datura which parallel many of those formerly obtained with Œnothera, and in a striking series of experiments have extended those results in various directions.

In recent years, a number of predictions of peculiar cytological conditions have been made on the basis of genetic experiments, and afterwards confirmed by observation of the cells. An example is the work of Bridges with strains of Drosophila having an extra chromosome. This condition arises, as was first shown in Œnothera, through failure of one pair of chromosomes to enter separate nuclei in reduction, a process which is now known as non-disjunction.

The following may now be regarded as generally

[1] Opening paper of a joint discussion of Sections D (Zoology) and K (Botany) at the Toronto meeting of the British Association on August 12.

accepted facts concerning the chromosomes. They are bodies of relatively fixed size, shape, and point of attachment to the spindle fibres. Homologous pairs usually separate in meiosis and thus furnish the basis for simple Mendelian behaviour. Their number is generally fixed for each species so far as the germ-lineage is concerned. The relations of genetical crossing-over to chromatin behaviour are complicated and need not concern us here. Aberrant chromosome numbers arise in various ways and produce forms with different external characters. Such forms have been specially investigated in Œnothera, Drosophila, and Datura. The most striking changes found are tetraploidy ($4n$ chromosomes), triploidy ($3n$), and non-disjunction leading to forms with an extra chromosome ($2n+1$, $4n+1$, etc.). These conditions occur in all three genera, except that tetraploid forms have not been observed in Drosophila. The condition found in Œnothera particularly furnished the first experimental basis for a comparison of the chromosome numbers in various wild and cultivated species of plants.

When we examine the chromosomes of related species of plants and animals, differences in number or in size and shape of the chromosomes are often found. How have these differences originated? The answer to this question has already given us the beginnings of a chromosome phylogeny, which can now be soundly based on analogy with experimental results. The case of *Œnothera gigas* furnished the first experimental clue to the origin of tetraploidy. Many wild tetraploid species of plants are now known, and they must have arisen in some such way as *Œ. gigas* appeared, *i.e.* as mutations. The tetraploid and higher polyploid species are turning out to be surprisingly common in plant genera, though apparently much less frequent in animals.

Before considering further the phenomena of polyploidy, let us attempt to classify the various types of change which are indicated to have taken place in the phylogeny of chromosomes by the comparison of related species or genera. We may mention:

1. Polyploidy, or the development of higher multiples of chromosome numbers.

2. Transverse segmentation or fragmentation of all the chromosomes, or of particular pairs. A phenomenon of this nature seems to have occurred on a large scale in the phylogeny of the Liliaceæ, where in such genera as Yucca, Albuca, and Eucomis, a number of pairs of short chromosomes take the place of certain long pairs in other genera. In the tetraploid *Primula Kewensis,* a transverse segmentation of all the chromosomes is shown by measurements (Farmer and Digby) to have taken place. In certain species of Hyacinthus and Carex the sum of the lengths of a medium and a short chromosome is equal to the length of a long one, indicating that transverse segmentation of a long one may have taken place.

3. The end-to-end fusion of certain chromosomes. This is particularly clear, both from genetical and cytological evidence in certain species of Drosophila, and appears to have happened in various other cases. The basal number of chromosomes in the Muscidæ appears to be 6 pairs. In different species of Drosophila the n number may be 6, 5, or 4. In *D. melanogaster* and *D. Willistoni,* which have 4 pairs, two of these are long and broadly V-shaped, with a median constriction, and each of these has evidently been formed by the permanent end-to-end attachment of two chromosomes. That *different* chromosome pairs have undergone this union in these two species is shown by the different genetic relationships of their characters in breeding experiments; and that the tendency towards end-to-end union still continues is indicated by the recent discovery of a strain of *D. melanogaster* in which the two X-chromosomes in the females have similarly become attached to each other and behave as a single body.

4. The gradual diminution in the size of certain chromosomes until they disappear. That this evolutionary process has occurred in the Y-chromosome of various insects, is indicated by its range of size in different species, from as large or even larger than its mate the X-chromosome in some species, to a tiny body on the verge of extinction in others. Wilson showed, for example, in the Hemipteran genus Nezara that the Y-chromosome is nearly as large as the X in *N. hilaris,* but very small in *N. viridula.*

In the Copepod genus Cyclops a gradual diminution in the number of chromosomes, from 22 in *C. strenuus* to 6 in *C. gracilis,* is accompanied by reduction in the fifth pair of swimming feet. In another section of the genus a parallel process has apparently occurred, with corresponding gradual diminution of the chromosomes from 14 to 10 and a small pair. Here phylogenetic change has apparently been accompanied by the continuous diminution in size of certain chromosomes until they disappear. Whether such a process should be looked upon as an orthophyletic change arising in the germplasm is not at present clear, but the subject is evidently worthy of further investigation.

5. Irregular divisions or non-disjunction may lead to forms with additional pairs of chromosomes. If this condition becomes balanced it would be perpetuated in a new species. This may have happened in various species.

6. The recent genetic evidence from Drosophila and the behaviour of the chromatin in such forms as *Œnothera lata,* indicate that not only may chromatin fragments enter a nucleus and afterwards divide, but also that portions from one chromosome may become attached to another and thus alter the genetic relationships of the factors concerned. This process is one which must also be considered as important in the evolution of species.

7. In the genus Carex, Heilborn (1924) has shown that the haploid numbers in forty-four species run from 9 almost continuously to 42 and 56, but without multiple numbers. With increase in numbers there is a general decrease in size of the chromosomes, and the same is true of certain other genera, such as Lactuca. This is regarded as due to a limitation in the capacity of the cell for producing chromatin. Heilborn suggests that one of the most important methods of chromosome increase in Carex has been by mutations of the *Œnothera lata* type followed by a division of the extra chromosome.

8. Certain species and even genera with new chromosome content have probably arisen through crossing. There is some evidence, both cytological and morphological, that cultivated maize may have arisen from a

cross between the Mexican Euchlæna and some species of grass belonging to the Andropogoneæ. A much clearer case is the one recently described by J. Clausen. He finds that *Viola tricolor* and *V. arvensis* have respectively 13 and 17 chromosomes as haploid numbers. In a cross the F_1 plants have 30 chromosomes, but in certain of the pollen mother cells 47 were found, *i.e.* 13+17+17, a condition of semi-tetraploidy. Two later generations of plants were grown from these hybrids, the chromosome number continuing 43-46. When the chromosome number is a very unbalanced one in a hybrid, as in crosses between diploid and tetraploid forms, irregularities of meiosis usually occur with loss of chromosomes until the diploid condition is reached in the later generations of offspring. In this Viola hybrid, with less disparity in numbers and a doubling in one parental set of chromosomes, the hybrid may later settle down to uniformity, in which case it might be regarded as a new species with higher chromosome number arising from crossing. Probably various species with increased chromosome numbers have been produced in this way, as Winge has suggested.

It is thus becoming clear that chromosome changes have arisen in a variety of ways, including transverse segmentation or fragmentation, end-to-end union of certain pairs, gradual diminution and disappearance of certain chromosomes, non-disjunction, rearrangement of portions of chromosomes, crossing of species having different numbers, and polyploidy. In some of these cases, of course, a certain amount of nuclear and cytoplasmic readjustment may be involved, but we have no present knowledge of how this takes place. In the simplest cases of tetraploidy all the external changes appear to follow directly from the doubling of the chromosomes.

All of these processes of chromosome change have had their place in the evolution of the germplasm, but certain of them appear to have been characteristic of particular genera or families. Our knowledge of polyploidy is at present much more extensive than any of these other processes, and it is on an experimental basis.

From the work of the last fifteen years, it has become clear that polyploidy has played an important part in the evolution of many plant genera and families, and that it is of particularly common occurrence among the varieties of cultivated plants. If tetraploidy can be brought about, as seems likely, by a lowering of temperature when the fertilised egg is beginning to divide, then one may perhaps understand its prevalence in plants and its relative infrequency in animals where temperatures are more controlled. But that it can be produced in other ways is shown by its experimental production in mosses by wounding (Marchals), in Solanum by grafting (Winkler), and semi-tetraploidy at least by crossing.

The cases of polyploidy in plants that have now been investigated are far too numerous to be discussed here, but reference may be made to a few of them. The genus Rubus, in which Longley (1924) has recently found $2n$, $3n$, $4n$, $5n$, $6n$, and $8n$ species, has 7 as basal number. The basal number of chromosomes in Rosa is also 7. In the genera Prunus and Potentilla the fundamental number is 8, and several species of Potentilla are known to be tetraploid. In Cratægus, where $n=16$, Longley (1924) has found $2n$, $3n$, and $4n$ species. If 16 is the fundamental number in this genus, then the genus must have originated in connexion with a tetraploid mutation. In some species of Alchemilla $2n=64$ and they are therefore octoploid in comparison with the fundamental number. It is evident that further chromosome studies in such families as the Rosaceæ will throw light on the origin and relationships of genera. The fact that such notoriously polymorphic genera as Rosa, Rubus, and Cratægus are all found to show polyploidy in a high degree is a discovery too fresh for its significance to be fully realised.

Similarly in the evolution of various other genera and families, higher and higher polyploid numbers have been reached. Thus in the genera Chrysanthemum, Rumex, and Rosa, species are found which are $2n$, $4n$, $6n$, and $8n$ in their chromosome constitution. Some of these genera also have $3n$, $5n$ and even $10n$ species. Many of these species are apogamous, and where the chromosome number is an unbalanced one as in $3n$ and $5n$ species, it can only be maintained by apogamous or vegetative reproduction. Thus these unbalanced species must always have been apogamous from their origin.

The conditions in the wheats, where $n=7$, may be briefly mentioned. Einkorn wheat (*Triticum monococcum*) is diploid, the species of hard wheat are tetraploid, and the Vulgare wheats (soft), which comprise our highest yielding modern sorts, are hexaploid. When members of different groups are intercrossed they produce sterile hybrids. All three groups go back to prehistoric times. The tetraploid wheats presumably arose, like *Œnothera gigas*, through a sudden doubling in the number of chromosomes. The most probable hypothesis of the origin of the $6n$ condition is that it came from a $3n$ hybrid between diploid and tetraploid species, one such hybrid having doubled its chromosomes, perhaps in the fertilised egg, and so restored its fertility. In certain cultivated varieties of mulberry, the $3n$ condition is maintained by apogamy, and the same is true of the wild species *Eupatorium glandulosum* and *Erigeron annuus*. Similar polyploid conditions are being found in many cultivated plants, including bananas, pineapples, oats, and dahlias, so that much more evidence concerning the precise manner of origin of these conditions ought to be obtainable.[2] Enough is already known to show that several different kinds of, for example, tetraploidy exist.

The development of sterility between species has undoubtedly played an important part in evolution. How this condition has come about is still a matter of speculation, but we are beginning to get some light on the subject. The old view that forms which produced fertile hybrids must belong to the same species has completely broken down, as has the converse conception that in plants, sterile pollen is a proof of hybridity. One of the most interesting features of tetraploidy is its relation to the development of sterility. As has been pointed out elsewhere,[3] if a tetraploid form such as *Œnothera gigas* arises in Nature, its hybrids

[2] Some of these subjects have been more fully discussed elsewhere Polyploidy, *Brit. Journ. Exptl. Biol.*, 1, 153-182, 1924.
[3] NATURE, 1922, vol. 110, pp. 179, 447.

with its diploid parent must contain an unbalanced chromosome content, and this leads to the dropping out of chromosomes in later generations until the diploid number is restored.[4] The triploid form can only perpetuate itself by developing apogamy (as certain triploid species and varieties have done) or by doubling its chromosomes, thus producing a hexaploid form. In all three cases new centres of stability will be reached, which are starting points for fresh variations. The essential conditions for physiological isolation are produced, because the cross-breds will be unbalanced and unable to perpetuate themselves, while the original diploid and tetraploid forms will go on as independent lines of descent.

Blakeslee [5] and his collaborators have recently gone a step further and made the important discovery that the tetraploid mutation from Datura is almost completely sterile with its diploid parent. This is the first time that a form has been shown to appear in cultivation which is sterile with the form that produced it. In other respects it appears to be a complete parallel to the case of *Œnothera gigas*. It is thus proved not only that germinal changes can take place leading to new centres of variation, but also that they may be accompanied by practically complete sterility with the parent form. The origin of species which fail to cross with their parents, or of forms which produce sterile hybrids, is thus seen to be concerned in many cases with morphological changes in the chromosome content, such as tetraploidy.

In this way tetraploidy and the higher forms of polyploidy, as well as other types of chromosome change, have been of great importance in evolution, since they have the effect of physiological isolation even when there is no isolation in space. Genera and species which are tetraploid in comparison with related forms may be expected to have arisen in Nature in this way. Nor is this condition confined to higher plants, since various mosses and ferns, and Isœtes, are known to show similar conditions.

The study of chromosomes thus leads to results of far-reaching importance for evolution. It is of the highest importance for taxonomy in determining the relationships of species and genera. With advancing knowledge and quicker methods of examining chromosomes, the time should come when the description of a species is not considered complete until the morphology of its chromosome group is known, for visible chromosome differences, when they occur, throw important light on relationships. With further knowledge we shall doubtless learn much concerning the phylogenetic nature of the various kinds of chromosome change which have been outlined here. They suffice to indicate that there is a fundamental evolution of the germplasm, of which changes in specific characters are merely the external expression. Already as regards tetraploidy these changes have been experimentally analysed and we know something of the conditions which bring them about.

How the environment, acting on the organism, may have influenced other kinds of chromosome change we do not know at present. But it is well to remember that if a radium atom can undergo spontaneous changes and break-down, then the infinitely more complex physical arrangement involved in a group of chromosomes may be reasonably expected to undergo equally spontaneous changes, especially during the complicated process of meiosis. It may also undergo alterations in which the environment of the cell has only been very slightly concerned. As an additional means of investigating phylogeny, the chromosomes have already furnished evidence of the highest importance, and their further study will no doubt throw important light upon the methods of evolution.

Modern genetics has led us to deal, as Bateson has said, with the world of gametes which form the background for the visible inherited variations of species. The next decade of comparative and experimental work with chromosomes will bring the realisation that in the secular changes of the chromosomes, however controlled or determined, we have a means of understanding how the cell unit, and through it the organism, has varied in structure in the past from species to species. This gives a new line of approach, of fundamental importance, in the analysis of the processes of evolution. It is to be hoped that its significance will be recognised, not only by experimental evolutionists as an additional line of evidence in tracing phylogenies, but also by taxonomists as a necessary element in their discrimination of genera and species.

From a phylogenetic point of view, two important principles have emerged from the work of recent years in experimental evolution and other fields. One of these is the principle of parallel mutations, which introduces a new element of fundamental importance into the reconstruction of phylogenies. The original case of parallel mutations experimentally determined was that of the *lata* mutation from *Œnothera Lamarckiana* and from *Œ. biennis*, both mutants having 15 chromosomes and the same peculiarities of leaf and habit and sterile pollen, but each having the flower-size of the species from which it was derived. Innumerable cases of parallel variations are now known in plants, and many in animals. They appear to have originated as mutations. Vavilov, in particular, has directed attention to their frequency in cereals, Leguminosæ, and other families. When their significance is appreciated by systematists they will have a profound effect on present conceptions of relationships and phylogeny, for they show that many similar variations have occurred over and over again in unrelated groups.

The other principle to which I may make a brief reference has been emphasised particularly by palæontologists in recent years.[6] We may call it *orthophylesis* to avoid the special connotations of previous terms. It consists in the recognition of longer parallel phylogenetic trends in different lines of descent. What relation, if any, these orthophyletic trends bear to parallel mutations remains to be investigated. But it is possible that some of them, at any rate, as pointed out earlier in this paper, may be the result of changes initiated in the chromosomes. In any case the comparative study of chromosomes offers one of the most promising lines of advance in experimental evolution.

[4] See Gates, "The Chromosomes of a Triploid Œnothera Hybrid," *Ann. Bot.*, 37, 565-569, 1923.

[5] Blakeslee, Belling, and Farnham, "Inheritance in Tetraploid Daturas," *Bot. Gaz.*, 76, 329-373.

[6] See Watson, D. M. S., Croonian Lecture, Royal Society, 1924 (NATURE, June 7, p 841).

The Light emitted from Solidified Gases and its Relation to Cosmic Phenomena.

By Prof. L. VEGARD, University of Kristiania.

IN previous communications [1] I have given accounts of investigations on light emitted from solid nitrogen exposed to cathode rays and its bearing on the auroral spectrum. The conclusion was reached that in the auroral region the temperature was so low that nitrogen existed partly in the form of minute crystalline particles. If these particles are of molecular order of magnitude, the state is very much like a gas, from which, however, it differs in one respect. The constituent particles are not molecules with identical mass, but each particle may contain a more or less arbitrary number of atoms arranged in a space lattice characteristic of the solid state. This state, which is something between a gas and a solid, we shall call a pseudo-gaseous state.

Although it is difficult or perhaps impossible to produce this pseudo-gaseous state in laboratory experiments, still I was able to show that a layer of solid nitrogen when bombarded with cathode rays of small velocity gave a spectrum which was essentially the same as the auroral spectrum. In the green, the spectrum from solid nitrogen consisted of two bands, N_1 and N_2, corresponding to the auroral lines 5577 and 5230, and in addition it showed in the blue and violet the band-heads which are typical for the auroral spectrum.

The work has been continued at the Cryogenic Laboratory of Leyden and I have been able to study the new effect under varied conditions, with different kinds of rays, and I have also experimented on layers of various gases. In order to determine more exactly the position and structure of the bands, I have used a spectrograph of considerable dispersion. With the largest dispersion used, the distance between the yellow helium line (5875·6) and the green helium line (5015·7) was 27 mm.

I have obtained about a hundred spectrograms of the light effect from solidified gases and made a number of interesting observations which will be dealt with in greater detail in a later work. In this article I propose to give a short and preliminary account of some of my recent results.

Already in my first publication I mentioned that while the line N_2 was fairly sharp, N_1 was broad and covered the spectral region 5525-5660, and further it showed some structure. The spectrograms at larger dispersion [2] showed that N_1 had three maxima, one strong and two weak.

The position of the maxima varies somewhat with the experimental conditions. From one of my spectrograms with large dispersion I find that N_1 covers a region between 5528 and 5655. For the principal maximum I find $\lambda = 5555$, and for the two weak ones 5611 and 5649. Also with the greater dispersion, N_2 appeared as a single but somewhat diffuse line with a wave-length 5229·4, which agrees very well with the wave-length (5230) given in my first publications.

So long as we are unable to experiment on a pseudo-gaseous state of solid nitrogen, we cannot make an exact comparison between the wave-length of N_1 and that of the prominent green auroral line. Under the conditions of the experiments, N_1 does not define any definite wave-length, and we can merely state that N_1 is extending on both sides of the auroral line. The sharpness of the latter must be due to the smallness of the particles, and the prominent green auroral line is to be regarded as the limiting aspect of the band N_1, when emitted from solid nitrogen particles of molecular order of magnitude, which exist in free space.

I have been able to make some experiments which actually show that the bands get sharper when the particles are reduced in size. When an inert gas which contains traces of nitrogen is condensed on the cold surface, the layer will contain small nitrogen particles surrounded by an inert substance. In this state, we should expect nitrogen to behave in a similar way as if the particles existed in free space. Experiments were carried out in mixtures of argon and nitrogen. In one series I used canal rays, in another swift cathode rays; but in all cases I found that the N_1 band became narrower when the concentration of nitrogen became smaller.

At the same time I observed the remarkable fact that *the position of the principal maximum changes with the nitrogen concentration.* For small concentrations the principal maximum approaches a wave-length 5604. Thus with varying composition of the mixture the principal maximum oscillates between the values 5555 and 5604. The "secondary" maxima seem to disappear when the concentration of nitrogen is very small.

The motion of the principal maximum approximately follows the relation

$$\lambda_0 - \lambda_p = \frac{p}{100}(\lambda_0 - \lambda_{100}),$$

where λ_p is the wave-length corresponding to the percentage p of nitrogen and λ_0 and λ_{100} are the limiting positions.

The motion of the band may be due partly to the change of the average size of the nitrogen particles and partly to a mutual influence between argon and nitrogen. Perhaps an X-ray analysis of the crystalline mixture would give some information regarding this point. At any rate, the experiments indicate that a reduction of the size of the particles makes the band sharper, and that the position of the line corresponding to a pseudo-gaseous state need not coincide with any of the maxima observed in ordinary nitrogen under the conditions of my experiments.

The contraction of the bands does not seem to be essentially effected by change of temperature. By working under reduced pressure with liquid hydrogen, the temperature of the layer was lowered from 20° to 14° K.; but there was no contraction of N_1 to be observed, although a change of a few per cent. would have been detected.

The experiments in argon mixtures also give an interesting illustration of the extremely high emission power of solid nitrogen. Even very "pure" argon contained sufficient nitrogen to give a marked emission of N_1 and N_2, and the nitrogen afterglow. The addition

[1] Proc. Roy. Akad. Amsterdam, vol. xxvii Nos. 1 and 2; NATURE, vol. 113, No. 2846, p 716; C.R. Acad. Sc. t. 178, p. 1153.
[2] Spectra with larger dispersion were obtained about the middle of March.

of about 0·1 per cent. of nitrogen to the "pure" argon considerably increased the nitrogen effect.

As shown in my earlier communications, slowly moving cathode rays gave in the blue and violet just the same negative and positive band-heads as those typical for the auroral spectrum. The effect has since been photographed with a quartz spectrograph through a quartz window, and the spectrum in the ultraviolet showed the same positive band-heads as those observed in the auroræ.

When the layer is bombarded with a powerful beam of cathode rays from a Wehnelt cathode, a deep red luminosity appears near the layer, and the colour has the same appearance as a red colour very characteristic of the auroræ. A spectrum obtained on a panchromatic plate showed the same two red bands which I have obtained on auroral spectrograms. Thus from the system I am experimenting upon I get the characteristic bands and lines of the auroral spectrum from red to ultraviolet.

Now it is of great importance to see whether also positive rays might give the typical auroral spectrum. For this purpose a considerable number of experiments have been made with canal rays acting on nitrogen, hydrogen, and helium.

Exposed to canal rays, solid nitrogen emitted both N_1 and N_2; but in the blue, violet, and ultraviolet, the canal-ray spectrum was quite different from the typical auroral spectrum. In this spectral region the canal-ray spectrum was dominated by a series of diffuse bands, which extended far into the ultraviolet. Moreover, as has been shown before, the canal-ray spectrum has a number of strong lines not present in the auroral spectrum.

Thus neither in the solid nor in the gaseous state of nitrogen do the canal rays produce the nitrogen spectrum observed in the auroræ, and hence we conclude that by far the greater part of the auroræ must be caused by cathode rays.

Cathode rays which were produced by an induction coil and had a fairly large velocity corresponding to a spark-gap of 5-6 mm. between spheres 1 cm. diameter, gave a very brilliant effect, showing N_1 and N_2 very strongly. Under these conditions I also obtained the same series of diffuse bands as were obtained with canal rays, but their intensities were now relatively smaller.[3]

Nitrogen-argon mixtures were investigated both with canal rays and swift cathode rays, and some results with regard to the variations of N_1 have already been described. Not only N_1, but also the diffuse canal-ray bands in blue and violet, were seen to contract as the concentration of nitrogen became smaller, and at the same time each maximum moved towards shorter wave-lengths. When the layer of argon only contained small quantities of nitrogen, the bands were concentrated into fairly well-defined diffuse lines. In the blue and violet there were two bands, each of which was concentrated into one pair of lines, one pair at $\lambda = 4523$, 4473, and the second at $\lambda = 4236$, 4211.

These bands are no doubt one state of development of the two bands observed by Lord Rayleigh in the light from the night sky. This means that this light should be produced by fairly slow positive rays.

[3] It remains still to be shown that the bands in blue-ultraviolet are not produced by canal rays, either retrograde rays or rays produced by imperfect rectification of the current.

When the layer of solid nitrogen has been bombarded for some time with canal rays or swift cathode rays, the afterglow becomes very persistent. Two or three minutes after the rays are cut off the light intensity from the layer may remain practically constant for hours or perhaps for days. Usually the afterglow only shows the band N_2; but when the persistent afterglow is very strong, I have also observed N_1 and the bands in the blue.

When the liquid hydrogen disappears and the temperature of the layer gradually increases, the stored energy is suddenly released under intense light emission, showing N_2 very strongly, but also N_1 and the diffuse bands in the blue appear very strong. Thus N_1 and N_2 and the series of diffuse bands in the blue-ultraviolet are emitted in the afterglow and consequently from the very interior of the solid substance.

When the temperature of the layer increases to a certain point the appearance of the solid nitrogen suddenly changes. At the temperature of liquid hydrogen the layer resembles a piece of ice and sticks to the cold surface; but at a certain point the layer assumes a powdery form, and if it is somewhat thick it falls down from the cold copper surface. The existence of two modifications of solid nitrogen was discovered some years ago by means of cooling curves,[4] and the transformation is found to take place at a temperature of 35·5° K.

Now the energy stored in the afterglow radiates out at the very moment that the layer passes over into the other modification. The phosphorescent energy cannot exist in the modification which is stable above 35·5° K. This phenomenon is explained from the fact that the light given out by the afterglow is characteristic of the modification of solid nitrogen which is stable below 35·5° K., for if nitrogen in the other modification is exposed to cathode or canal rays, N_1, N_2, and the diffuse bands in the blue-violet are not emitted. The luminosity, which is very faint, shows a different spectrum and no afterglow.

This fact has a very important bearing on cosmic phenomena. In that part of the atmosphere where N_1 and N_2 are emitted the temperature must be below 35·5° K., and the isothermal surface 35·5° K. marks the transition between an upper layer very easily excited to light emission and a lower layer which has lost this high emission power.

In this way I think we get the explanation of the fact found by Lindemann that the meteor frequency as a function of altitude shows two maxima with a very marked minimum in between, for below the isothermal surface (35·5°) the meteors may often seem to disappear because they produce very little light until farther down they become luminous on account of heating. Now the height of this isothermal surface ought to be greater in the day than in the night, greater at the equator than at the poles, and greater in the summer than in the winter. Indeed, Lindemann has found that the height of the upper frequency maximum, caused by nitrogen below 35·5° K., increases from 75 km. in the winter to 85 km. in the summer.

The relative intensity of the lines N_1 and N_2 is of importance not only from a physical point of view, but also in connexion with the auroral problem. The

[4] W. H. Keesom and H. Kamerlingh Onnes, Proc. Roy. Akad. Amsterdam, 24, p. 1315.

intensity ratio N_1/N_2 increases generally with velocity and the density of the bombarding electric rays, and in nitrogen-argon mixtures it increases very much when the nitrogen concentration diminishes. With very small concentrations N_1 predominates as compared with N_2. This effect indicates that N_1/N_2 increases as the nitrogen particles get smaller, and it may thus account for the predominance of the auroral line 5577 in the auroral spectrum.

The great variability of N_1/N_2 makes it difficult to determine exactly the minimum cathode ray velocity necessary for producing the two bands. Perhaps they require the same velocity, only that the intensity of N_1 usually is very small at small velocities. At the present time, I have been able to follow N_2 down to velocities corresponding to 78 volts, and N_1 down to 165 volts.

A non-luminous layer of solid nitrogen was not made luminous by ultraviolet light from a condensed aluminium spark. X-rays, however, produced the ordinary afterglow.

When the layer is in the state showing the persistent afterglow, conditions are different. In this case light from an ordinary incandescent lamp with a tungsten filament produced a very marked increase in the intensity of the afterglow. In some cases the intensity underwent very marked periodic variations with periods of 5-6 seconds, and I could count 8-9 periods.

Layers of solid oxygen, ammonia, and argon have been bombarded with both cathode rays and canal rays, and a layer of nitrous oxide with canal rays only. With the exception of argon, the light effect was feeble and gave no afterglow. The fairly strong effect observed from an argon layer was to a great extent due to traces of nitrogen, which produced a weak afterglow and a strong emission of N_1 and the canal-ray bands of nitrogen. The afterglow showed only the line N_2 and no other visible light in the spectrum. Thus argon itself gives no afterglow, and the real argon effect, although somewhat stronger; perhaps, than in the case of oxygen ammonia and nitrous oxide, is an effect of the same type as shown by these gases.

The experiments on layers of various substances thus show that the light effect from nitrogen at temperatures below 35·5°, which is applicable to the auroral spectrum, is a light effect of a unique and singular type.

The Beam System of Radio Telegraphy.

THE paper read by Senator Marconi to the Royal Society of Arts on July 2, and published in the Journal of the Society for July 25, describing the results he has obtained over very long distances by short wave directional radio telegraphy, is one of great importance and marks an epoch in the development of long distance radio communication. Mr. Marconi reminds us that more than twenty-eight years ago he showed Sir William Preece the transmission and reception of signals over a distance of nearly two miles by a "beam" system, using short waves and reflectors. Curiously enough, at that time he could only transmit signals by means of an antenna over a distance of half a mile. The rapid and spectacular progress made, however, by the long wave system in those early days diverted attention from short wave research, although the latter could be emitted in beams in definite directions.

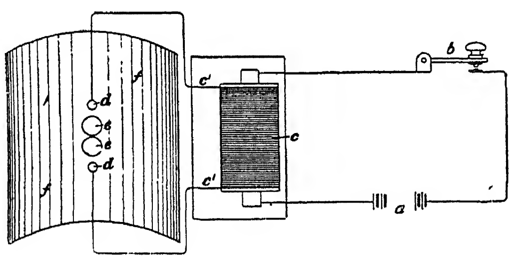


FIG. 1.—Spark transmitter and sheet metal reflector, 1896.

In 1899, Mr. Marconi read a paper to the Institution of Electrical Engineers in which he pointed out that a short wave system would be of value in connexion with lighthouses and lightships in foggy weather, enabling them to locate dangerous points. He also projected a beam of waves across the lecture room, a bell ringing only when the reflector faced the receiver (Figs. 1 and 2).

In 1916, in conjunction with Mr. C. S. Franklin, he again began to make researches with directive beams. The reflectors used at first were not solid sheets of metal, but consisted of wires forming a cylindrical parabolic reflector, the antenna forming the focal line of the cylinder (Fig. 3). The reflectors now used consist of a grid of antennæ and a grid of reflecting wires arranged parallel to one another (Fig. 4). Special arrangements have to be made so as to ensure that the phase of the oscillations in all the wires is the same. The great value of reflectors was demonstrated by experiment, the energy received being increased about two hundredfold by their use.

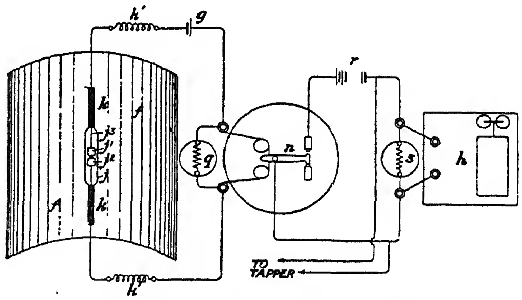


FIG. 2.—Coherer receiver and sheet metal reflector, 1896.

Many tests were carried out between the steam yacht *Elettra* and a small station erected at Poldhu which emitted waves about 100 metres in length, the frequency therefore being about 3,000,000. One definite result obtained was that the strength of the signals received during the hours of daylight varied inversely with the mean altitude of the sun over the space intervening between the two stations. It is wrong, therefore, to refer to distances covered during daylight as "day ranges." It shows also that the tests which were carried out partly within the tropics during the months of May and June were made under very unfavourable conditions.

The results prove quite definitely that the absorption factor given in the well-known Austin formula does not apply to short wave phenomena. It can be replaced by a factor which is approximately a linear function of the mean altitude of the sun calculated on the great circle of the earth which passes through the two stations. In regard to atmospheric disturbances and others, the origin of which is unknown, these appeared to be less troublesome during daylight than when working with a long wave system. During night time, even up to distances of more than 2000

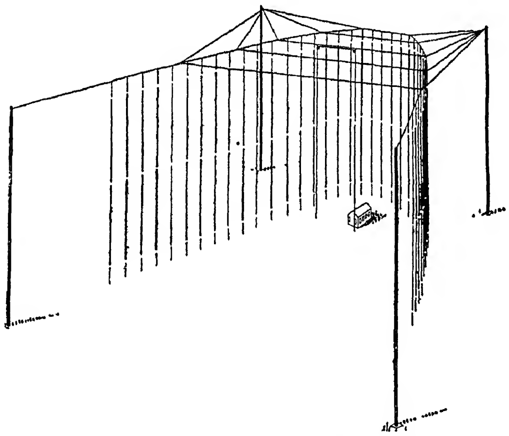


FIG. 3.—Parabolic vertical wire reflector, 1923

miles, the signals received were so strong that extraneous disturbances caused no appreciable interference.

During the tests, the Poldhu transmitter consisted of eight glass valves in parallel, the input being only 12 kw. The radiated energy concentrated by the parabolic reflector in the direction of Cape Verde was about 9 kw. If no reflector had been used, about 120 kw. would have been necessary to get a beam in that direction of the same intensity. The receiving aerial was a vertical wire at a height of twenty metres above sea-level. The first series of tests was carried out without the transmitting reflector. Day signals were received up to Seville, which is 780 miles from Poldhu, although practically the whole of Spain, consisting of more than 300 miles of high and mountainous country, lay between the sending and the receiving station. At Gibraltar (820 miles), better signals were obtained, as the yacht was anchored in a more open space.

For greater distances the reflector wires were used at Poldhu. At Madeira (1250 miles) good signals were obtained, using 12 kw. at the sending station. At St. Vincent (2230 miles), Cape Verde Islands, it was still possible to get a few hours' daylight reception after sunrise and before sunset. The night signals continued to arrive with apparently unabated strength although the distance had been increased to about double what it was at Madeira.

The strength of the night signals at St. Vincent was estimated to be about 500 microvolts per metre of aerial wire, and no trouble was experienced from any kind of interference. It was calculated that night signals would continue to be received at St. Vincent even if the power at Poldhu were reduced to the tenth of a kilowatt.

After this voyage, the station at Poldhu was improved, the power being increased to 20 kw. Since February of this year further tests have been made. A special short wave receiver was installed on the s.s. *Cedric*, and reception tests were carried out with Poldhu during a journey of the vessel to New York and back. No reflectors were used at either end. The results obtained confirm the earlier experiments. Daylight signals could be received up to a distance of 1400 nautical miles.

During this test one surprising result was obtained. Mr. E. T. Fisk, of Sydney, Australia, reported by cable that he could receive the Poldhu transmissions perfectly well every day at his house from 5 to 9 P.M. (G.M.T.). He also received them between 6.30 and 8.30 A.M. He used an improvised receiver consisting of a 2-stage high frequency tuned plate and grid with one rectification. Every word that was sent had been read, and Mr. Fisk stated that the signals were better than any he had received from the high power station at Carnarvon. Further experiments on communicating with Sydney were made, and consistently good results were obtained.

The experimenters conclude that during the morning period the waves start from England to Australia in a westerly direction. The waves cross the Atlantic and Pacific Oceans, a distance of approximately 12,220 nautical miles. In the evening they travel in an easterly direction over Europe and Asia. This is the shortest route, being only 9380 miles.

In Canada, at Montreal, reception was possible for sixteen hours out of the twenty-four. A successful wireless telephonic test was made with Sydney on May 30, the speech being intelligible and easily heard. It is noteworthy that this great distance was obtained without the use of a reflector at either end. The use of reflectors would doubtless be a great advantage in practice as it would both strengthen the received waves and cut out all the extraneous disturbances except any which are proceeding in the line of the beam.

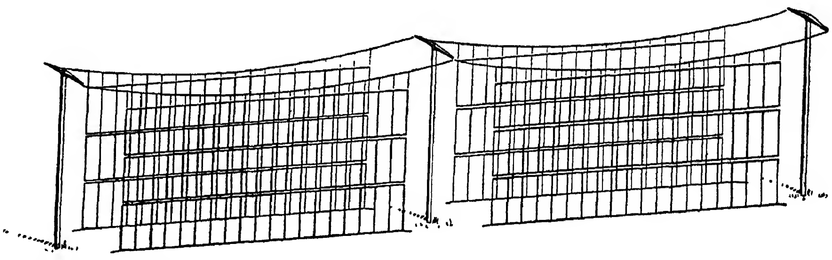


FIG. 4.—Vertical wire flat transmitting aerial and reflector, 1924.

The aerials used were never worked to anything approaching the limit of their carrying capacity. It would be quite possible in practice to superimpose several waves and thus send several services simultaneously from the same aerial. The speed of working obtainable by using short waves is very much higher than that obtainable by the long waves now in general use.

Mr. Marconi calculates that the speed of signalling with a 100-metre wave, having a frequency of three million, will probably be a hundred times as great as that obtained with a frequency of 30,000, which is of the order of those that it is proposed to use for the Imperial Stations.

Further tests in June last were made between Poldhu and a small receiving station at Buenos Aires in the Argentine (5820 miles). A parabolic reflector was employed to concentrate the energy stream towards the Argentine. Although the power radiated was only 17 kw., strong signals were received for more than ten hours a day at Buenos Aires.

Mr. Marconi is strongly of opinion that by means of these small and inexpensive stations a far greater number of words could be transmitted between England, India, and distant British Dominions than would be possible by means of the previously planned powerful and expensive stations. The communications also would be much more secret than that obtainable by any of the present systems. In conclusion, he expresses his high appreciation of the excellent work done by Mr. C. S. Franklin in this connexion.

Obituary.

Sir George Beilby, F.R.S.

Sir George Beilby died on July 31, in his seventy-fourth year, and when he had just laid aside the harness by which he had so long applied his talents with great effect in varied fields. His death caused widespread regret and directed attention to a notable record of public service in the linked relations of science, industries and citizenship. Fortunately for industry his early work brought him into close touch with the details of production as well as with scientific problems which confronted the chemical manufacturer. His skill and thoroughness in investigation, and his clear appreciation of the conditions of large scale work, enabled him to make successive additions of much value to the methods of industry. His relations with commercial production became such that he was in a position to follow up his researches in science by investigation of those of their applications which seemed to be promising. The success which from time to time attended his steady and enthusiastic labour enabled him to give to public purposes much of his energy, as well as to afford substantial support towards the advancement of science and the training of promising recruits for the ranks of scientific workers. Withal, the man and his life will remain in the minds and hearts of many, young and old, as a beacon no less bright than his work.

The son of Dr. G. T. Beilby, a well-known medical practitioner in Edinburgh, Sir George was born there in 1850. He was educated in Edinburgh schools and the University, and he joined the staff of the Oakbank Oil Company as a chemist in 1870. This appointment marked the opening of his professional work, which falls into three periods commencing in 1870, 1890, and 1914 respectively.

1870–1890.—A few years after joining the staff at Oakbank, Beilby became manager, and he held this position until about 1890; thus from 1870 to 1890 his work centred on the Scottish oil industry. He introduced improvements in several sections of the work, the most important being the use of large volumes of superheated steam which was passed into and through the spent shale in the retort, converting the carbon of the shale into water-gas and the nitrogen largely into ammonia. This procedure had several notable advantages, of which the main one was that it more than doubled the yield of ammonia—a result which saved the Scottish oil industry from extinction during the years of severe competition by petroleum.

The minor advantages of the process were: (1) the water gas, formed and heated in the lower part of the retort, conveyed heat internally to the shale in the upper portion, thus assisting to distil the shale at moderate heat; and (2) the removal of carbon from the spent-shale was practically complete, so that fires in the spent-shale "bings" which made these a nuisance in their neighbourhood were avoided. Beilby erected his original retort, operated on these lines, at Oakbank, but later he associated himself with the late Mr. James Young, who was experimenting on similar lines, and together they brought out the "Young and Beilby" retort (patented 1881), which is the prototype of the existing forms.

It is of interest to note that the use of steam in gas production with the purpose of recovering the nitrogen of the coal as ammonia was first proposed by Beilby, who practised it on an industrial scale at Oakbank Oilworks.

Towards the close of the first period of his work Beilby's attention had been attracted by the advent of the McArthur Forrest patents (1887) for the extraction of gold from its ore by means of cyanides. The probable demand for cyanides appeared to him to open an extensive field for chemical industry, and he proceeded to investigate the possibilities of preparing cyanide cheaply. This led shortly to his putting down a small factory near Edinburgh, where he produced the material in fair quantities at a price much lower than that reached by other makers.

1890–1914.—Beilby laid his cyanide process and its results before the directors of the Cassel Gold Extracting Co. of Glasgow (now the Cassel Cyanide Co., Glasgow). His process was accepted, and he became a director and partner in the firm. The process was used exclusively and profitably by this Company until 1900, when Castner introduced a new process for cyanide manufacture, on the development of which Beilby and Castner worked together. The improved process which they worked out was adopted by the Cassel Cyanide Company. At this time Beilby joined the board of directors of the Castner Kellner Alkali Co., Glasgow, and until the outbreak of war he took a leading part in the development of the two companies mentioned.

While this period consolidated Beilby's position as one of the pioneers and leaders of recent progress in chemical industries, it also brought to the front a parallel line of his activities in research—*the using of fuel*—and in this connexion it led to a steady increase

in the proportion of his time devoted to public work. Concurrently with his early work in the development of the recovery of ammonia from shale at relatively low temperatures, he had conducted experiments in steaming bituminous coal. From this onwards he never lost touch with the national problems of prevention of smoke and the economical use of coal. His work on fuel came prominently before the public when he took part in the inquiry of the Royal Commission on Coal Supplies in 1903. He then submitted an analysis of the purposes to which the British output of coal is applied and an estimate of the scope for economy attainable in each category of use by improved methods. His subsequent investigations were at first (1906–1912) directed to the production of a smokeless fuel for domestic purposes. The record of that work, communicated at the 1913 meeting of the British Association, showed that in treating comparatively non-caking coals satisfactory economic results could be obtained. The experiment was, however, discontinued, for the inquiries of the Royal Commission on Fuel and Engines for the Navy, 1912–13, gave a new and wider significance to low-temperature carbonisation. Lord Fisher was chairman of the Commission, and Beilby, as one of its members, could bring to the table not only full knowledge of ascertained fact, effective processes and attained results, but also a ready appreciation of the broad considerations specially relevant to the issues before the Commission. The Commission reported that the only means of rendering Great Britain to some extent self-supporting in the matter of fuel-oils lay in the development of a new carbonising industry founded on the distillation of coal at a temperature much below that used in gas-retorts or coke ovens.

1914–1923.—It was to the problem thus set to British science and British industry that Beilby gave of his best in the last ten years of his life. During the earlier War years his work and his thoughts were much diverted to other issues; but the fuel question was never far off.

When Lord Balfour, then First Lord of the Admiralty, formed the Board of Invention and Research with Lord Fisher as chairman, Beilby was naturally appointed to the Board. It is understood that in much of the great work with which that Board had to deal he proved most fertile in suggestion and wise in consultation and advice. On this section of his public service it may be recalled that in the King's birthday honours list for 1916 he was included among the new knights, being described as "a well-known chemist and inventor, who has specially studied fuel economy, and has rendered service to the Admiralty as a member of the Central Committee of the Board of Invention and Research, and in other ways."

In 1915, when it had been decided to reply in kind to the gas attacks first made by the enemy on the Ypres sector on April 22, 1915, Beilby was sent for by Lord Kitchener, at whose request he arranged that the Castner Kellner Company should provide a supply of liquid chlorine in cylinders. He became a member of the War Office Committee then formed to devise and test materials for offensive chemical warfare. On the formation of the Ministry of Munitions this matter was transferred to the new Ministry. Throughout these years Beilby gave his whole time to work for the Government, mainly in the Trench Warfare Department and its successor, in 1917, the Chemical Warfare Department. Needless to say, the work of the various advisory and supervisory War Research Committees was most strenuous and exacting. Beilby was indefatigable and resourceful always. He was much more. His calm, careful and sympathetic consideration of every intelligent suggestion or criticism were of great value in securing for the service the best use of the talents of the willing and able workers in the field. His individual contributions to scientific investigation of problems arising on appliances for attack or defence were always clear and definite; his guidance on points affecting design with the view of mass production or on suggestions for expediting manufacture was thoroughly practical. The anxieties of the time were many and often sudden. On such occasions Beilby was a great asset. His quiet manner, his refusal to be fussed, the personal sacrifices he made as a matter of course, and his consideration for all who worked with or under him, were of the highest value in the improvised organisations of the time.

But already in 1915 the Government had taken a first step to prepare for attacking the problems which would have to be faced on the advent of peace. A Committee of Council for Scientific and Industrial Research had been constituted, and in 1916 the Department of Scientific and Industrial Research was established, with a strong advisory council of men of science as the central feature in its organisation. Of this council Sir George Beilby was one of the original members. In its first year the council, recognising that fuel was at the root of British industry, advised that the Department should tackle the fuel problem. A year later, despite his other national work, Beilby was prevailed upon to accept the invitation to direct fuel research for the Department, put to him first by Lord Crewe, when Lord President of Council, and again by Lord Curzon when he succeeded to that office. The Fuel Research Board was set up in 1917 with Beilby as its chairman and as Director of Fuel Research.

The burden which Beilby thus took up was a heavy one, and at the initiation of the work he was closely engaged in the war activities indicated above. Moreover, the past strain had pressed him not a little and he had had to undergo an operation for appendicitis. While still feeling the effects of that, he had returned to his war work with his customary energy; indeed his spirit appeared to have carried him through without lasting effects.

The design, construction and equipment of the fine Fuel Research Station at East Greenwich were carried through under Beilby's personal supervision, so that the station, its possibilities, its organisation and its staff represent his conception of what is required as the centre of national investigation and research as to fuel production and the using of fuel. The development of the relation of the Fuel Research Board and of its central station to investigations carried out in coalfields and other laboratories had necessarily to wait for more normal conditions, but this, too, had been arranged and initiated before he regarded the organisation as being on a basis so secure that he was justified in demitting the office of Director of Fuel Research.

By the end of 1917, the first year of the work of the Station, the problem set by the Fisher Commission of 1913 had been solved in its scientific and technical aspects sufficiently to permit home production of fuel-oil under war-conditions if need had continued to press. Commercially it still stands a problem. The normal work of the Fuel Research Board has been noted from time to time in these columns. It therefore suffices here to say that the whole organisation is to all intents and purposes Sir George Beilby's creation. That early result of reference to the Board—the establishment of the method of charging for town gas by the "therm"—is now recognised as one of those little things which exercise prevailing influence to the advantage of producers and consumers alike.

Sir George Beilby was never without a side interest or hobby with a scientific bearing. He took a keen interest in colour photography and in microscopy. In the former he made himself expert in the use of the Lumière process in photographing mountain scenery in Switzerland and the Tyrol, and he applied it also in photomicrography. Indeed, some of his photomicrographs, prepared in 1913, were reproduced in a colour-plate published in NATURE of February 19, 1914. Microscopy, from being a hobby, became, and continued, for him a serious study. It was the only method of investigation which he could follow with satisfaction intermittently in casual short intervals in the busy daily life of a busy man. Faced, as a cyanide manufacturer, with the difficulty of finding any metal tube which would withstand the action of ammonia at 700° C. for any length of time, he turned to the microscope for suggestions as to the conditions of the problem.

From this Beilby was led to investigate the effects of various forms of mechanical work on the crystalline structure of metals, for example, the disturbances which occur in the processes of polishing and burnishing. As usual he spared no pains in making himself a master of the technique of the methods which he employed to study his subject from every angle. He made an experimental study of a number of solids in various states of aggregation. His researches in this field, which were ingeniously planned and most accurately carried out, were of an entirely novel kind. He gave an account of this work in the May lecture which he delivered to the Institute of Metals in 1911. In his book, "The Aggregation and Flow of Solids," 1921, he published collected statements of his work on this subject, including his more recent investigations. The facts he recorded are those which he established by most careful work and observation repeated time and again. These and the theory of the hard and soft states of metals which he put forward in 1911 had a profound influence for several years on the development of metallography, and gave rise to a variety of researches designed to test the range of application of his theory. In view of recent researches on the constitution of matter it is difficult to judge the precise form of the theory which will ultimately be accepted, but there can be no two opinions as to the magnitude of the service he rendered to the elucidation of the changes produced in metal crystals by mechanical work of all kinds.

As a citizen—indeed in all relations—Beilby systematically shunned publicity. Even in matters of public interest for which he did active work, his help was so unobtrusive that it was little known unless circumstances made his emergence unavoidable. Education, training for and in research, smoke prevention, each succeeded in identifying him, but these were by no means the limits of his active help in affairs. In 1877 Sir George married Emma, daughter of the Rev. S. Newnham, and Lady Beilby has been a devoted coadjutor in many of his public interests. With her he was early among those who worked for the admission of women to professions, and this cause appealed to him in the first instance in the critical case of medicine. Their interest in students, particularly students of science, began many years ago, and only few have even a general idea of the extent to which he coupled financial help with advice as to courses of training or subsequent experience. Sir George was one of the trustees of the Carnegie Trust for the Universities of Scotland, and he took a keen interest in the details of the work of that Trust. He was a fellow of the Royal Society, and one of the first members of the executive of the National Physical Laboratory formed by the Society in 1900 with Lord Rayleigh as chairman.

It was, however, the Glasgow and West of Scotland Technical College—now the Royal Technical College—which indented most fully on his ready help in council. He was co-opted as a governor of the college in 1900, and on the Board of Governors his wide knowledge of men of science and of industry soon commanded the confidence of his fellow-governors, and his foresight did much to secure that the building then being planned was conceived on an adequate scale. In 1903 he became convener of the sectional committee on the departments of chemistry, technical chemistry and metallurgy. The scheme of teaching and the nature of the laboratory courses and appliances adopted were novel at the time, but have since proved applicable in other places. In 1907, on the death of Sir William Copland just when he had completed the task of raising funds for the erection of the new buildings for the college, Sir George Beilby was elected chairman of the governing body.

The new buildings and equipment secure, the governors and staff strove strenuously, and with success, to raise the standard reached in the college teaching and to develop the training of promising students in methods of research bearing on industries. In 1913 the college was affiliated with the University of Glasgow and was included among the institutions recognised for grants by the University Grants Committee. The raising of the college ideals and the effective efforts towards improvement of practice were largely due to the all-prevailing influence and wise initiative of the chairman. His fine personality was a great asset in every development of the college and its work.

One example of this may now be mentioned. Sir George had been providing funds year after year to enable good men to remain at college for training in research methods for a year or more after completing their ordinary courses. When the results of this encouragement had become amply apparent he set about placing this help and cognate facilities on a

permanent footing. A "New Development Fund" was established and started by an anonymous contribution of 10,000*l*. Sir George was the donor. He was one of those who knew how to use money to good purpose. The fund was well opened, and although the war years checked its growth it now amounts to 65,000*l*.

Sir George Beilby's fine personality was a great asset in every development of the Royal Technical College and of its work. His touch with students was, however, of long standing and it was real, informal and elevating. His house in Glasgow was for years a place of resort for young men. Music had a home there—Sir George himself was an artist in music; he was also a first-class craftsman; he built his own organ, buying only the pipes, and much of the refinement of its mechanism was of his own invention. Conversation there on current topics never flagged in interest although it often strayed. Personal talk or counsel on individual aims or on difficulties over study always refreshed the visitor.

In our world of to-day—its science, its industries and its humanities—Sir George Beilby has been a notable exemplar of the "veray parfit gentil knight."

WE regret to announce the following deaths:

Sir William Bayliss, F.R.S., professor of general physiology in University College, London, on August 27, aged sixty-four.

Dr. John J. Stevenson, professor emeritus of geology at New York University and president in 1899 of the Geological Society of America, on August 10, aged eighty-two.

Current Topics and Events.

THE recent conference at Oxford on "The Scientific Approach to Religion" was a notable event and aroused a good deal of interest in the Press and the public. The change of tone is amazing since the famous Diocesan Conference at Oxford in 1864, when Disraeli strolled in and declared himself on the side of the angels and not of Darwin. Of course the battle had been won long before this, but it was well that Oxford should be the scene of so striking a reconciliation after the half-century. The notes struck were, the abandonment of final and exclusive dogmas either on the side of science or of religion, and the possibility of a man of science being a theist and Christian, and of the "religious" person accepting all or any of the established conclusions of science. We imagine that nowadays few people will be found to dispute any of these propositions. We all agree in general terms; the difficulties arise when we come to define them. This could be illustrated from almost any of the papers read. For example, Dr. Rollin stated that the point of the theists had been demonstrated that the world in its essence was a form of energy, and energy, so far as all our knowledge went, did not come from nowhere. But would such a doctrine satisfy any theist who thought out carefully what he meant, or would it have convinced Ostwald that he was a theist? The fact is that such an eirenicon as was proclaimed last week in Oxford is rather testimony of general goodwill, of a change of temper, and of a readiness to examine, than of definite agreement as to really disputable points. For what it was, we heartily welcome it and would not add a word to hinder so healthy a process. We need above all to strengthen the bases of our intellectual and social amity, but let us make sure of the strength of the stones we lay. It would be a disaster if they crumbled into sand when we began to raise the superstructure.

AT a recent meeting of the Wiltshire Archæological Society a discussion took place with reference to permission having been granted to a modern sect styling themselves "Druids" or "Church of the Universal Bond," who contemplate burying the ashes of their dead within the precincts of Stonehenge. The discussion was followed by a strong protest against this unseemly intrusion. It is only a few years since this well-known monument was handed over to the nation by a generous donor, and as it came thereby under the protection of H.M. Office of Works, it was hoped that this would effectually stop desecration and any future trouble. A question in the House of Commons regarding a rumour of the proposed burial of ashes, put by the member for the Salisbury Division to the First Commissioner of Works, elicited the reply that permission had actually been given. Apparently the Commissioner had been approached by the sect privately and gave the desired permission on his own initiative without consulting the Advisory Board or taking thought what the result might be. This deplorable attempt at vandalism is strongly resented in the County and by the public generally, who hold in reverence the mighty monument set up by our progenitors. The members of the "Church of the Universal Bond" have camped for a fortnight annually upon the downland about half a mile from Stonehenge, and the Office of Works, despite suffering irritation from them, generously gave permission for services to be held within Stonehenge. Instead of being grateful for this boon an insulting letter was sent in reply, asserting that the place belonged to the sect, and no advantage was taken of the concession. Apparently an attempt is now being made to secure a hold upon the place, and this move should be resisted vigorously and to the utmost by every one who has a regard for Stonehenge. It is ridiculous to think of a small and obscure set of people having the impertinence to arrogate a claim to this National Monument. With just as much reason another sect might arise calling themselves "Romans" and laying claim to Roman villas.

SPAIN is a country rich in archæological remains, and many are the investigators who have made notable discoveries there. English readers have been hearing from time to time about the work of Mrs. Wishaw and the founding of the Anglo-Spanish School of Archæology at Niebla, Huelva, in Andalusia. A long article on her discoveries appeared in the *Times* of August 23, and we have received the following note upon it from a contributor, M. C. B.:—Mrs. Wishaw's

investigations cover a rich and interesting field of Roman remains, including waterworks, etc., which is not dealt with in the article. Next, many finds have been made dating back to pre-Roman (Iberian) times. These discoveries include objects of pottery, etc., many of them exceedingly important. It is perhaps a pity that Mrs. Wishaw has not concentrated on these two fields where such valuable finds can be made, and where she has already done work of undoubted service to the archæologist. Her chief interest and object, however, seems to be to demonstrate that Upper Palæolithic man flourished at Niebla, even arriving at the stage of building walls and making pottery, and the recent article is largely devoted to this subject. Although the writer has not yet had occasion to visit the Niebla site itself, he has had the opportunity of seeing some examples of the stone industries, and he can only unhesitatingly suggest that, unless there is something further to show, nothing is as yet advanced which in the least proves the occurrence of Palæolithic man there. The specimens seen were, in his opinion, at earliest no older than the Neolithic Age. It is to be hoped that Mrs. Wishaw will continue her work, more especially on the later cultures. Spain possesses the advantage of having in the person of Dr. Obermaier, of the University of Madrid, one of the most brilliant of European prehistorians, and he would undoubtedly be willing to help at any time in dating the finds.

ON August 25 a report, unsupported by details, appeared in various newspapers to the effect that 9·4 inches of rain had fallen in six hours at Cannington, Somerset, during a "cloudburst." It has since been ascertained that 9·04 inches were measured at Brymore, one mile west of Cannington, at 9 A.M. on August 19. The observer estimated that, of this amount, 8·5 inches of rain and hail fell between 3 A.M. and 7·30 A.M. on this date. At the Bridgwater Water Works, Ashford, about one mile from the Cannington gauge, 4·50 inches were measured. Further particulars with regard to this downpour will be awaited with interest, and some suspension of judgment is necessary until the measurement has been finally confirmed. A fall of eight and a half inches at an average rate approaching two inches an hour is quite unprecedented in the British Isles, though this rate has of course been frequently exceeded in short periods. The total amount of 9·04 inches has only been exceeded on one previous occasion, namely at Bruton, Somerset, on June 28, 1917, when 9·56 inches fell. During the climax of that disturbance the rate of fall reached one inch per hour for two hours. A similar rate was observed in the great East Anglian rain of August 25-26, 1912. On the day of the recent "cloudburst," a depression was stationary over the northern part of the North Sea and shallow secondary disturbances were passing over the British Isles. The conditions were favourable for heavy local showers of a thundery character. No large amounts of rain were, however, measured at health resorts or Meteorological Office telegraphic reporting stations in south-west England. At Weston-super-Mare, the nearest station the observations of which are telegraphed to the Meteorological Office, the total fall for the twenty-four hours ending at 9 A.M. on August 19 was only 7 mm. (0·28 inch).

THE Royal Society of Western Australia, as part of the commemoration of the Kelvin centenary, has instituted the award of a gold medal for research. The medal will ordinarily be awarded every four years, and the first recipient is Dr. William J. Hancock. This is awarded in recognition of the part which Dr. Hancock has played in the development of radiography and radiotherapy in Australia since the discovery of X-rays. Until recently Dr. Hancock was the Government Electrical Engineer and is an honorary member of the Institution of Engineers of Australia. Those who took up the practice of X-rays soon after their discovery had many difficulties to overcome, and for a long time their pioneer work entailed real scientific investigation, the results of which rarely found their way into print. Nevertheless, it was largely due to these men who began to apply X-rays for medical purposes that the technique has evolved on the present lines. Unfortunately, few of these pioneers escaped injury from the rays they were using, and we regret to learn that Dr. Hancock is not an exception in this respect.

IN the Faraday lecture of the Chemical Society, which has appeared in the July issue of the Society's journal, Prof. R. A. Millikan devoted attention to certain aspects of atomic structure which are receiving particular attention at the present time, especially from the spectroscopists. As a preliminary he insisted upon the very definite nature of the proof we now possess of the existence of the electron, citing in this connexion his own famous experiments with the oil drop, which the latest researches in his laboratory have rounded off in a very convincing manner. Then, after summarising our knowledge of the nucleus atom, and emphasising the success of the orbit theory as worked out by Bohr and his followers, in particular Sommerfeld, he proceeded to describe briefly some recent experiments carried out by himself in collaboration with Mr. I. S. Bowen. Working with the so-called hot spark, in extreme vacua, these investigators have succeeded in obtaining spectra emitted by atoms which have, in extreme cases, lost as many as six of their "outer" electrons. In the first group of the periodic table they find evidence for the existence of "stripped" atoms, *i.e.* atoms which have lost all their outer electrons, of all the elements from lithium to nitrogen, the last-named having, of course, lost five electrons: in the second group they have obtained stripped atoms of all the elements from sodium to sulphur, which involves a loss of six electrons in the last-named. This constitutes a notable extension of the work of Prof. A. Fowler and of Prof. Paschen, who have obtained respectively the spectra of doubly and trebly ionised silicon, and of doubly ionised aluminium. For the identification of the lines, Prof. Millikan has derived much support from the increase of doublet separation with nuclear charge, which agrees well with the Sommerfeld relativity formula applied to his assumptions. Further consideration of his results has led

Prof. Millikan to conclude that the electrons possess inverse-square-law fields of force at orbital distances. The detailed account of this work has not yet been published, and will be awaited with keen interest by all physicists. It may be noted that Prof. Millikan comments unfavourably on the static atom, which he calls the "loafer electron theory," to express in brief the conception of "electrons sitting around on dry goods boxes at every corner, ready to shake hands with, or hold on to, similar loafer electrons in other atoms." He also objects to the term "proton," preferring "positive electron."

PROF. FREDERICK SODDY, professor of chemistry in the University of Oxford, has been elected a foreign member of the Reale Accademia Nazionale dei Lincei of Rome.

PROF. A. S EDDINGTON, Plumian professor of astronomy and experimental philosophy in the University of Cambridge, has been elected an honorary member of the American Astronomical Society.

IT is stated in the *Times* that a French pilot, Lieutenant Thoret, has made a record gliding flight at the aerodrome of Les Alpilles, near St. Rémy-en-Provence. He remained in the air with the engine of his machine stopped for 9 hr. 8 min. The previous record was held by a German airman, who was in the air for 8 hr. 42 min.

FOR the past year, Dr. J. J. Simpson, Keeper of Zoology in the National Museum of Wales, Cardiff, has given a weekly chat on some natural history subject from the British Broadcasting Company's studio in Cardiff. He has dealt in one series with British mammals, and these are to be published shortly in book form by the Sheldon Press. He has now started a new series on "Romances of Natural History," and has already dealt with "The Eel," "Aquaria," "Sticklebacks," "The Honey Bee," "The Tadpole," "Our British Reptiles and Amphibians, etc.," and will, during the next few weeks, talk on "The Mayfly," "The Sponge," "The Salmon," "The Lamprey," etc. It is noteworthy that the Cardiff station was the first to inaugurate a series of such talks, and from the correspondence received it is evident that they are stimulating a wide interest in natural history. It was inevitable that such would be the case, because the various subjects are dealt with in non-technical language, and must appeal to a large public both juvenile and adult.

MR. F. EDWARDS, 83 High Street, Marylebone, W.1, has just circulated Catalogue No. 461 (British Empire Series, No. 4), containing particulars of nearly 800 books, engravings, and drawings relating to Africa. Copies are obtainable from the publisher upon request.

THE autumn announcement list of Messrs. Edward Arnold and Co. contains two memoirs which should appeal to readers of NATURE, namely, "The Life of John William Strutt, Third Baron Rayleigh, O.M.," by his son, the present Lord Rayleigh, and "Huia Onslow," by his widow, Muriel Onslow. Lord Rayleigh over a long period was a frequent contributor to NATURE, and a short series of articles on "The Iridescent Colours of Insects" by Mr. Onslow appeared in our columns not long before his death.

AMONG the autumn announcements of Messrs. Longmans and Co. is a book by Prof. S. J. Hickson entitled "An Introduction to the Study of Recent Corals," in which attention will be given to the structure by which corals capture and digest their food, the colours they display in life, and the means by which they propagate their kind. A description of the structure of the soft parts of the coral and of its appearance when alive will be given wherever possible in the description of the genera.

ERRATUM.—In issue of August 30, p. 302, col 1, line 32, for "as well as the study of science, that of letters" read "the study of science, as well as that of letters."

Our Astronomical Column.

ENCKE'S COMET.—This comet was of magnitude 14 at the end of July, but it has been rapidly approaching both sun and earth, and should now be visible with ordinary telescopes, especially before September 10, as the moon will be troublesome after that date. The following ephemeris, for Greenwich midnight, is from the B.A.A. Handbook:

	R.A.	N. Decl.	log r.	log Δ.
Sept. 5.	5h. 53·0m.	36° 46′	0·0845	9·9948
9.	6 21·4	37 10	0·0621	9·9670
13.	6 53·2	37 7	0·0378	9·9406
17.	7 28·2	36 28	0·0113	9·9170

The comet is nearest to the earth on September 30, and to the sun on October 31. It is due south about 7 A.M., but from its high northern declination it is observable in the east shortly after midnight. On September 5 it is near θ Aurigæ, on September 17 some 4° north of Castor. It should be followed until about October 20, after which it is inconveniently near the sun, and rapidly moving south.

ABSORPTION IN THE ATMOSPHERE.—M. J. Baillaud describes, in the *Comptes rendus* of the Paris Academy of Sciences, May 26, observations on the coefficients of transmission of light of different wave-lengths by the atmosphere, made at the Pic du Midi Observatory. A curve resulted, more or less parallel to that obtained by Rosenberg at Göttingen, but with somewhat higher values, and agreeing still better with that of Abbott and Fowle taken at Mount Wilson. On October 21, 1921, however, the values for small wave-lengths, about 380 mμ, were abnormally small, the curve running into the normal curve for longer wave-lengths. It was noticed that, although the sky was very clear, hoar frost was deposited on the outside wall of the observatory, and it is suggested that there may be a special absorption band for water vapour, which has not as yet been observed in the laboratory, when it is in the unstable state which precedes condensation. In support of this hypothesis, the observation of Nichols and Pacini, that the short wave-lengths are weaker in proportion to the long ones in light from clouds than in that from the clear sky, is brought forward. It does not seem possible that the abnormal absorption was due to ozone, as the amount of this gas required to produce the effect would be some seventeen times larger than that normally existing in the atmosphere.

Research Items.

THE DISTRIBUTION OF CALAMITIES.—Four months ago attention was directed in these columns (vol. 113, p. 653) to a proposal to study the distribution of calamities such as earthquakes, epidemics, floods, etc., under the auspices of the International Red Cross Committee and of the League of Red Cross Societies. A chief feature of this proposal was the issue of a quarterly review, *Matériaux pour l'étude des calamités*, to be edited by M. Raoul Montandon. We have now received the first number of this journal containing articles by the editor on the geography of calamities, and by M. Louis de Launay on earthquakes and volcanoes, as well as notices of memoirs bearing on the subject. The main object of the movement is the relief of suffering among populations affected by great calamities, and the editor urges that a useful preliminary step in the organisation of relief would be the publication of an atlas of the world showing clearly the site and extent of all catastrophes.

ACTIVE PHILIPPINE VOLCANOES.—The Bulletin for April 1922, recently published, in 1924, with the authority of the Government of the Philippine Islands, contains an article on the above prepared under the direction of Rev. José Algué, S.J., Director of the Weather Bureau of the Manila Central Observatory. Data relative to the Philippine volcanoes were previously published in 1901 and 1903. Since then volcanic events have been described in the Bulletins of the Weather Bureau, and observations of particular volcanoes were undertaken chiefly by the geologists of the Bureau of Science. The author mentions that the Apo and Sarangani extinct volcanic chain is in line with the Sanguire group, which is still active, lying about 200 kilometres south of Sarangani, across the north-east part of Celebes Sea. A prominent peak or cone of the Apo group is Matutum; this is a very old volcano, its local name Matutum meaning "has burnt" or "fire out." With reference to the group Makaturing and Ragang, the author is inclined to believe that all the historic eruptions attributed to the former occurred in the latter. Dealing with volcanoes on Luzon Island, especial reference is made to Taal volcano, said to be probably the lowest in the world. It rises in the centre of Lake Bombon, in 14° 2′ N., 120° 57′ E.; the altitude of the lake is less than a metre above sea-level, and the highest wall of the crater is about 300 metres. The last eruption occurred in 1911 and annihilated everything around within a radius of several kilometres, causing about 1300 deaths.

CURRENT METER RATING.—The rating of a current meter for recording the discharge of streams is, of course, an important procedure, and every care is essential in order that the rating shall be carried out under conditions approximating as closely as possible to those obtaining in the actual observations. The customary method of calibrating a meter is to draw it through still water at known speeds, simultaneously observing the corresponding speeds of the rotor. The objection has been raised that this is merely a record of parallel and uniform stream line flow, taking no account of variations in the speed and direction of the filaments of water characteristic of ordinary river discharge. Such variations are generally grouped under the designation of turbulence. In NATURE of June 14, p. 872, we referred to a turbulence gauge designed by Mr. B. H. Wade of the Egyptian Ministry of Public Works to record the effects of turbulence in connexion with the computation of discharge in the river Nile. We have now received a copy of Physical Department Paper, No. 14, issued by the same service, in which Dr. P. Phillips discusses certain experiments which he has made on the rating of current meters by means of a new rating apparatus, brought into use at Abbassiya Water Works, by which the three essential observations (time, revolution of rotor, travel of carriage) are recorded automatically, so eliminating personal errors. This apparatus has been found to give results agreeing closely with the makers' average rating curve, and with the rating of the United States Bureau of Standards. It records a smaller number of revolutions per minute for the same velocity than does the old apparatus at Giza, the difference ranging between 2 and $5\frac{1}{2}$ per cent. for different velocities. The new apparatus is explained with the aid of diagrams and photographs.

IMPLANTATION OF THE HUMAN OVUM.—Prof. J. H. Teacher has contributed to the summer number of the *Journal of Obstetrics and Gynæcology* (vol. 31, No. 2) an important paper on the implantation of the ovum and the early development of the trophoblast in man. That the human ovum burrows into the uterine mucous membrane, parasite-like, destroying tissue and provoking inflammatory and reparative reactions, has been recognised for some years. This memoir contains an account of the further discovery that the closure of the decidua reflexa is effected by an apparatus developed from those ectoderm cells of the ovum which are the last to enter the mucosa tissue. This apparatus unites with the uterine epithelium and afterwards with the other tissue of the lips of the aperture through which the ovum has passed. For the complete structure the author suggests the term "operculum deciduæ." The recognition of this apparatus has led to the identification in the human ovum of a polar arrangement similar to that found in the hedgehog and in the guinea-pig. The ovum, therefore, may be described as having an entering or implantation pole and an adhering or closing pole, and it is this polarity which determines the position of the embryonic rudiment in the blastocyst and the situation of the placenta. The operculum, which differs from the Traeger of the rodent in taking no part in the formation of the placenta, usually becomes detached from the blastocyst when its function of closing the aperture has been fulfilled, a shield of fibrin being formed by thrombosis in the implantation cavity and so closing the passage from within. Prof. Teacher finds that the conclusion formerly arrived at by himself and Prof. Bryce that there are two generations of trophoblast (a primitive or implantation and a placental trophoblast) is entirely justified. These and many other cognate matters are dealt with in this memoir. It is illustrated by fifteen magnificent plates (some coloured), the cost of which has been defrayed by the Carnegie Trust for the Universities of Scotland. The material used in the investigation consisted of the original "Teacher-Bryce" ovum, first described in 1908, and a new human ovum of somewhat later age. The recent literature of the subject containing accounts of other early ova is referred to so as to facilitate a comparative study of the various processes described.

DIFFUSION AS A FACTOR IN ORE DEPOSITION.—In a paper on "Some problems of diffusion, with special reference to the study of ore deposits" (Science Reports of the Tohoku Imperial University, 3rd Series, vol. 2, Nos. 1 and 2, pp. 105-185), Manjirô Watanabé gives the results of some investigations on diffusion, amplifying the work done previously by Liesegang and others, but giving special attention to

the bearing of diffusion phenomena on ore genesis. Following Liesegang's method, experiments were made with gelatin media. Experiments were made also with kaolin, sand and calcium carbonate, in order to approximate more closely to natural conditions of ore deposition. As reacting materials, the sulphates, carbonates, nitrates and chlorides of common metals, sodium and barium sulphides, ammonia, and sodium carbonate or bicarbonate were employed. The velocity of diffusion with simultaneous precipitation was investigated, and a new equation proposed for the expression of diffusion velocity under these conditions. This equation is $x/\sqrt{z} = K(Z-z)/Z$, where z is the time and x the distance of diffusion, Z the time from the commencement of diffusion to the critical point of precipitation, and K is the velocity coefficient or the value of $x/\sqrt{z}$ at the commencement of diffusion. An examination of the magnitude of diffusion effects in Nature led to inconclusive results, but it is inferred that, contrary to the claim made by some previous workers, the effect of increased temperature in promoting diffusion is comparatively small; and that it takes more than 10,000 years for diffusion to take place over a distance of 100 metres. Other problems investigated include rhythmic precipitation, zonal or differential precipitation, and the action of various solutions diffusing into colloidal precipitates of metallic compounds. The order of stability of various sulphides in acid solutions, from more stable to less stable, was found to be as follows: silver sulphide, copper sulphide, lead sulphide, zinc sulphide and ferric sulphide.

THE ECONOMIC UTILISATION OF COAL.—In the June number of *State Technology*, the journal of the Institute of Professional Civil Servants, Mr. H. E. Weaver has an article on coal, directing attention in simple language to facts long recognised by fuel experts but little appreciated by the general public: that this commodity is an ever-wasting national asset and that its combustion in open grates is little short of calamitous. The proper utilisation of coal lies in its scientific carbonisation, the refinement of its many and varied products, as in the case of petroleum, and their economic use under the best conditions in national, industrial, and domestic life. To a large extent the coal-gas industry has pointed the way, and there is little doubt that its development to its present important position is due not so much to the actual production of gas as a common form of heat energy, as to the numerous and invaluable by-products to which its preparation gives rise. As is well known, the products resulting from retorting coal can, apart from the gases evolved, be grouped into two main classes—tar and ammoniacal liquor; the former is the basis of a wide range of oils, including anthracene, themselves the starting-points for the production of benzol, naphthalene, cresols, creosote, anthracene, to mention only a few compounds; linked up to the refinement of these products are a host of distinctive technical processes resulting in the manufacture of motor fuel, explosives, disinfectants, preservatives, drugs, and perfumes (mainly from treating benzol, toluol or xylol), the production of dyes from naphthalene, with alizarine and further dyes from anthracene; the solid products in the form of pitch and other hydrocarbons are likewise capable of refinement for the particular purposes to which they are to be put. From the ammoniacal liquor are prepared the valued ammonium salts and ammonia itself, cyanides, and sulphur compounds. One has only to remember the significance of cyanide in the South African gold industry to realise its importance as a factor which has made that industry possible. There is, in effect, such a wealth of possibility in the lumps of coal which we casually put on our domestic fires, that our action must seem little short of desecration to the "spirit of coal," cleverly portrayed on the posters issued by the Gas Exhibit Committee at the British Empire Exhibition, to which, and also to the instructive gas exhibit, the author rightly directs public attention.

THE PRODUCTION OF HIGH-VELOCITY β-RAYS BY THE ACTION OF HARD β-RAYS.—M. J. Thibaud has studied the β-rays produced by bombarding U, Pb, W, and Ag with the high-energy γ-rays of RaC (*C.R.* Paris Acad. Sci., July 21). The following table gives in the first line the symbol of the element employed as secondary radiator, in the second the energy in kilovolts required to detach an electron from the K level, and in the following the energies in kilovolts of the observed β-rays.

U.	Pb.	W.	Ag.
117	89·3	69·5	25·6
1004	1034	1057	1100
1122	1151		
1650	1677		

When the energies in the first line are added to those in the following lines, the energies of the γ-rays liberating the β-rays are found to be 1123, 1241, and 1763 in kilovolts; a γ-ray with energy 605 kilovolts has been previously found. All the important lines of the high-velocity β-ray spectrum of RaC, with one exception, are due to a photo-electric effect of the penetrating large quantum γ-rays. When radium is in contact with another element, there are two corpuscular emissions, giving similar spectra more or less shifted with regard to one another, the first being about four times as intense as the second. This agrees with the view of Ellis that the atom emitting the γ-ray has the greatest probability of absorbing it, and producing photo-electrons.

CONDUCTIVITY OF METALLIC VAPOURS.—Work has been done on the conductivity of metallic vapours in flames by a number of investigators, but Dr. E. Zachmann, in the July number of the *Annalen der Physik*, shows that a number of precautions which are necessary in order to measure the true conductivity have previously been neglected. He develops the theory and describes a very complete investigation of the vapours of the alkali metals. Two devices were adopted to prevent electrons from heated electrodes from penetrating into the flame; the hot surface of the Meker burner employed was made the anode, and electrons from it were driven back into it by the applied E.M.F.; the cathode stood above this, and was divided into a central portion of copper with a circular horizontal surface, surrounded by the horizontal surface of a metallic grid, which formed a guard ring; both portions of the cathode were water cooled. It was possible to adjust the flame so that, over a considerable vertical length, it could be shown that the field intensity was nearly constant. The probe electrodes employed were investigated theoretically and experimentally, and the best form for them was determined. It was found that the conductivity of the vapours of the alkali metals is proportional to the square root of the concentration in the flame, which agrees with the theory; it varies as the square root of the atomic weight of the metal, and increases rapidly with increase of temperature. It also appears that the production of electrons is almost entirely due to collisions between the metal atoms and the gas molecules of the flame, very few being due to collisions between two metal atoms.

Recent Industrial Research in Cotton.[1]

The volume of memoirs before us includes eight summaries of the current literature on such properties of cotton and cotton materials as are studied in more detail in the majority of the twenty-three other original papers. Although the plant is the source of supply of raw cotton, it is strange that these memoirs contain only one summary of existing literature on the application of botanical knowledge to immediate cotton industrial needs. The reason is that little trustworthy literature on this important subject exists.

The summaries are well compiled, and the length of the appended bibliographies (one includes 200 references) illustrates the care taken in their production. They are invaluable to scientific workers, in cotton and other allied textile materials, who are outside the British Cotton Industry Research Association.

The original papers are contributions from the botanical, physical, chemical, and physico-chemical departments of the Shirley Institute. Papers on the measurable characters of raw cotton, the morphology of the cell-wall of the cotton hair—which embodies some excellent photo-micrographs—and the conditions causing, and the prevention of, mildew in certain dyed cloths, form the bulk of the contribution from the botanical side. It is stated that infection of a cloth with a moisture content of 7·8 per cent. developed in nine weeks. Since raw cotton will absorb this quantity of moisture on exposure to an atmosphere of 0·66 relative humidity, which is far below the average value for the Lancashire district, the oft-recurring appearance of mildew in the raw material is not surprising.

The physical papers on the behaviour of cotton yarns under alternating stresses are characterised by the enormous number of tests made. Periodic variations which have previously been established in yarns tested by continuous loading methods, are found, in many cases, either to have disappeared or to have been considerably modified. Also, as neither of the two methods of testing is directly applicable to the study of stress effects in cloth, it is very doubtful whether, at this stage, the results obtained from thousands of tests on the peculiarity of any one yarn, very often the product of poor workmanship or the effect of efforts to increase production in the mill, are worth the highly trained labour expended on them. The writer is well aware of the variability of yarns spun under the best conditions, but cannot this be paralleled in the large scatter of rounds about a target engaged by a gun well and truly laid? A good gunner knows well that a comparatively long bracket is sufficient information to enable him to register the target roughly, if many other targets are to be registered in a limited time. Later, the interesting targets are then given the further attention which appears to be adequate.

The physical papers on the rigidity and plasticity of cotton hairs are very carefully done. It is doubtful whether the determination in absolute units of the coefficient of rigidity of a cotton hair, with its characteristically open structure, can be justified, especially when the influence of the relative humidity of the atmosphere on the physical constants of the hair is almost ignored. The force required to bend a dry cotton hair is greater than the force to bend the same hair containing 20·0 per cent. of moisture, even though the wet hair has the greater cross-section. The work on the plasticity of cotton hairs is of much higher order, and the magnetic torsiometer employed in this investigation is a cleverly designed instrument, well suited to the continuous measurement of small forces.

Two good methods of measuring the lustre of doubled yarns are described. The first is a direct photographic, and the second a photometric, method, in which the intensity of the light reflected from the yarn is compared with the intensity of light transmitted through a ground glass screen, illuminated in a controlled manner. A satisfactory method of measuring the lustre of yarns has been much needed, and the definiteness of the results obtained with the photometric method is encouraging. The general utility of the investigation is marred by the absence of information on the mercerising process used in preparing the yarn, on which process the lustre of yarns so much depends.

The investigations on the chemical constituents of the benzene extract from American cotton, and the volatile products derived from cotton by the action of water and sodium hydroxide at 40 lb. pressure, almost lead one to ask whether there is anything which cotton does not contain. The detailed examination of the extracts reveals the skill and patient labour involved.

Braidy's method of determining the copper number of modified and unmodified cotton cellulose has been found satisfactory after critical examination. The application of the results of colorimetric and titrimetric methods of determining the quantitative absorption of methylene blue by cotton cellulose of varying purity to the control of the bleaching process, to the detection of oxidation of cellulose (over-bleaching), and to the distinction between some raw Egyptian and American cottons, is perhaps the most interesting of the chemical contributions. The absorption of methylene blue by cotton cellulose is shown to vary directly with the ash content, thus confirming the conclusions of Rona and Michaelis and opposing the views of Bayliss.

On the physico-chemical side, work on the properties of starches used in sizing yarns is described. The results of the investigation on the moisture-absorbing properties of thin films of cooked starch bear a striking resemblance to those obtained on the moisture-absorbing properties of cotton. The botanical origin of the starch is found to have no appreciable bearing on the moisture-absorbing power. In contradistinction to this, the viscous properties of pastes made from maize and farina starches are shown to differ considerably.

Using a more sensitive form of the Justin-Mueller turgometer, the swelling of cotton cellulose in sodium hydroxide solutions has been examined. Although this attempt to find a means of eliminating discrepancies due to differences in the visible structure of cotton hairs was not successful, some interesting structural changes are noted.

Although these memoirs are an encyclopædia of information on the measurable properties of raw, spun, and chemically treated cotton, there is comparatively little cross-connexion or generalisation. They might be compared favourably with a Greek temple in the first stages of construction. The foundations have been thoroughly explored, and a number of pillars have been begun at very short spacial intervals. We are hopeful that the superstructure will be worthy of the stoutness of the supports; meanwhile, those who are only interested in the commercial value of the knowledge can trust in this solidity until such time as the superstructure takes a form which they can recognise. F. P. S.

[1] Shirley Institute Memoirs, vol. 2, 1923. Pp vi+394+v. (Manchester: British Cotton Industry Research Association, 1924.) n.p.

Orchard Heating in the United States.

MUCH progress has been made of late years in the study of fruit growing, especially with reference to orchard heating and the development of more accurate methods of predicting low temperatures and counteracting their damaging effects. Special information has been given in the U.S. *Monthly Weather Review* for different districts, notably for North Carolina, in Supplement No. 19, published last year; and the *Monthly Weather Review* for December last has an article on "Damaging Temperatures and Orchard Heating in the Rogue River Valley, Oregon," by Mr. F. D. Young, Meteorologist, and Mr. C. C. Cate, Plant Pathologist. Observations made in the past with regard to temperature are utilised by the authors.

The pear is the principal fruit crop of the valley, but so far less has been done in determining the damage by cold to this crop than to peaches, apples, and apricots. A large part of the article deals with the actual comparisons of the pear crops harvested from adjoining protected and unprotected orchards during the seasons of 1921 and 1922, and partially with 1923. The cold due to radiation with a clear sky is the special lowering of temperature dealt with. The upper and less protected parts of the tree feel the effect of radiation more fully. Fruit blossoms were examined and the extent of damage noted for the different exposures under examination, and from 150 to 350 blossoms were cut open and examined in determining percentages of damage at each count. The protected orchard is equipped with a various number of oil-heaters, ranging from about 9 to 250 2-gallon lard-pails to the acre. Graphs are given showing the range of temperature at unheated check stations and at heated orchards, the heating, in examples shown, making a difference of 4° to 8° F. The great value is clearly the maintenance of night temperature above the damaging point, say above about 30° F.

Excellent photographs are given showing the development of pear blossoms and fruit at different dates of progress, and of fruit in which the seeds have been damaged or undamaged by frost. Photographs also show the crop, in number of pears at different heights on the tree; for example—ground to 6 ft., 6-10 ft., 10-14 ft., and above. Also the cropping in boxes from respective trees in protected and unprotected orchards—ranging from more than 20 boxes to a single box—is given.

In one of the largest pear and apple orchards in the Rogue River Valley, orchard heaters have been used during the past thirteen years, and during that time the fruit crop has never been materially reduced through frost-damage. A rougher method of orchard heating was previously adopted, but it was far less efficacious.

Although the discussion under review deals only with the Rogue River Valley, it is stated that the effectiveness of orchard heating, where properly handled, applies with equal force in preventing damage by frost in Western Oregon and in the entire States of California and Washington. Detailed studies in southern California show that orange groves can be protected against outside temperatures of 18° F., and the protective value of heating is generally accepted by citrus growers throughout the State.

The economic phase of orchard heating has been intentionally ignored, although the authors give a few convincing facts in support of the cost incurred, and they note that, in the Pacific Coast States, orchard heating is generally practised only in the colder portions of each district.

University and Educational Intelligence.

LONDON.—Applications are invited for the William Julius Mickle fellowship of the value of at least 200*l*., to be awarded to the man or woman who, being resident in London, and a graduate of the University, has in the opinion of the Senate done most to advance medical art or science during the preceding five years. Applications must be received before October 1 next. Particulars may be obtained on application to the Academic Registrar, University of London, South Kensington, S.W.7.

THE University of the Witwatersrand, Johannesburg, gives in its Calendar for 1924 an interesting sketch of its origin and development. From 1916, when the Witwatersrand University Committee was formed for the purpose of developing the South African School of Mines and Technology, first into a full University College and ultimately into a University, progress has been very rapid, the number of students in each of the years 1916 to 1923 having been: 77, 173, 191, 301, 635, 812, 983, 1106. The University, formally opened in October 1922, has now fully organised Faculties of Arts, Science, Medicine, Commerce, Engineering, and Law, and a teaching staff of a hundred professors and lecturers.

THE United States National Research Council has published in Bulletin No. 38, particulars of more than 400 foundations of fellowships and scholarships for advanced work in science and technology. The compilation is provided with a subject index which shows that about 170 foundations are for research in pure science, 140 for research in technology, and 65 for medical research. A comparison with Appendix xxiv. of the British Empire Universities Yearbook seems to show that it is a much commoner practice among American than among British universities to admit to candidature graduates of institutions other than those in which the fellowships, etc., are tenable. The practice has obvious advantages, especially in the case of a university which has achieved pre-eminence in the advanced teaching, or facilities for the advanced study of, one or more branches of knowledge. From one point of view it is complementary to the practice of giving travelling fellowships.

AN Education Week is being organised for November 17-23 by the United States Bureau of Education in co-operation with the National Education Association (representing the school teachers of the United States) and the American Legion. The celebrations are to be distributed over the week thus: Monday, Constitution Day—"The Constitution: the bulwark of democracy and happiness"; Tuesday, Patriotism Day—"The United States flag is the living symbol of the ideals and institutions of our republic"; Wednesday, School and Teacher Day—"The teacher: the guiding influence of future America"; Thursday, Illiteracy Day—"Informed intelligence is the foundation of representative government"; Friday, Physical Education Day—"Playgrounds and athletic fields mean a strong healthy nation"; Saturday, Community Day—"Service to Community, State, and Nation is the duty of every citizen"; Sunday, For God and Country Day—"Religion, Morality, and Education are necessary for good government." For each day, appropriate topics and slogans are suggested. Conspicuous among those for the first two days are the following: Revolutionists, communists, and extreme pacifists are a menace to our constitution's guarantees of life, liberty, justice, security, and opportunity; the red flag means death, destruction, poverty, starvation, disease, anarchy, and dictatorship; stamp out revolutionary radicalism.

Early Science at the Royal Society.

September 6, 1664. Sir Robert Moray produced a letter of Mons. Huygens, dated at the Hague, mentioning an instrument devised by him for measuring the velocity of descending bodies; as also, a new observation concerning Saturn, made the last spring at Rome, by Campani, *viz.*, that the circle of Saturn had covered a part of its sphere above, and had been covered thereby below, even with a little shadow upon the circle below, and upon the sphere above: which observation Mons. Huygens looked upon as confirming his system, which himself had made.

1666. Sir Theodore de Vaux presented a paper of enlumineure which was recommended to Mr. Evelyn to peruse. This gave occasion to mention that Mr. Povey had intimated, that, upon the society's desire, Mr. Peter Lely, Mr. Cooper, and Mr. Streeter would perhaps not be unwilling to communicate to them the several curiosities and varieties of painting. Whereupon it was ordered, that Mr. Povey, Mr. Evelyn [and others] should be desired to meet and consider together what particulars were fit to inquire into, and thereupon to discourse with the said masters.

September 7, 1663. Dr. Wilkins put the company in mind to improve their former consideration of making an history of the weather, in order to build thereupon an art of prognosticating the changes thereof: And he suggested, that it might be recommended to some of the members of the society, to make constant observations, at least of the most considerable changes of weather: in order to which, Mr. Hooke was desired to engage therein, which he did; and Dr. Wilkins undertook to recommend the same to Dr. Power. It was also thought proper that Dr. Wren should be written to, to send to the society a scheme of his weather-engine, formerly proposed, in order to see whether it needed any addition or not. Sir Kenelme Digby related, that Dr. Dee by a diligent observation of the weather for seven years together, acquired such a prognosticating skill of weather, that he was, on that account, accounted a witch.—Mons. Huygens presented a paper from his father Mons. Zuylichem containing a description of a new kind of candlestick, by means of which, the candle upon it gives more light than two torches together, consumes less wax, frees from the inconvenience of smoking in the narrowest room, and needs no snuffers. The paper was ordered to be translated from the French.

September 10, 1662. It was ordered, that at the next meeting experiments should be made with wires of several kinds of the same size, viz., silver, copper, iron, etc., to see what weight would break them; Mr. 'Croune being appointed curator of this experiment.—Dr. Wren was reminded of prosecuting Mr. Rooke's observations concerning the motions of the satellites of Jupiter.—A proposition was offered by Sir Robert Moray about the planting of timber in England, and the preserving of what was then growing.

September 11, 1661. Two committees were appointed to propound experiments, one consisting of Dr. Goddard, Dr. Wilkins [and others] for the city of London; and the other consisting of the lord Viscount Brouncker, Sir Robert Moray, Sir Paul Neile [and others] for Westminster.

September 12, 1679. There was a discourse about ways of vision, from the assertion of Mr. Hooke, that a man used to see things always inverted would in time judge, that he saw them as they are. Sir John Hoskyns remarked, that looking at the sun or stars through a small hole made in paper caused them to appear less than to the naked eye. Dr. Croune gave the reason of the sun's appearing bigger near the horizon from the dilating of the pupil.

Societies and Academies.

PARIS.

Academy of Sciences, August 4.—M. Guillaume Bigourdan in the chair.—A. **Lacroix**: A new type of meteoric iron found in the desert of Adrar, Mauritania.—F. E. **Fournier**: An unpublished safety manœuvre for preventing collisions between steamships during fog.—A. **Haller** and R. **Cornubert**: Study of two symmetrical and unsymmetrical dimethylpentanones. Symmetrical dimethylcyclopentanone condenses with benzaldehyde in the presence of hydrochloric acid, giving a compound $C_{21}H_{22}O_2$: the unsymmetrical dimethylcyclopentane behaves differently, giving a true benzylidene compound.—Gabriel **Bertrand** and Hirosi **Nakamura**: A new case of physiological mutation in mice.—P. **Sergesco**: Some inequalities of Landau and Lindelof concerning monogene functions.—J. **Cabannes** and A. **Lepape**: The diffusion of light by krypton and xenon. The polarisation of the light diffused transversely by a pure inert gas is not total.—J. **Guinchant**: Rôle of the atmosphere in the propagation of Hertzian waves. Effects analogous with mirage in the case of light waves can be produced with Hertzian waves. The state of the lower atmosphere may be an essential factor in the propagation of radio-telegraphic waves. The changes in intensity and of direction of the waves, the differences in receiving during day or night, and influence of the seasons may be readily explained by normal meteorological variations.—André **Job** and René **Reich**: The catalytic activation of ethylene by organo-metallic nickel. A solution of phenylmagnesium bromide, to which a little anhydrous nickel chloride has been added, rapidly absorbs large volumes of ethylene. Subsequent addition of water gives ethane, ethylbenzene, styrolene and diphenyl, but no benzene.—H. **Gault** and Mlle. M. **Urban**: The soluble cellulose esters of the higher unsaturated fatty acids.—Max. and Michel **Polonovski**: The nitroso and benzoyl derivatives of eserine.—Ch. **Maurain** and L. **Eblé**: A photographic recording seismograph with three components.—MM. **Rothé**, **Lacoste**, **Bois**, Mlle. **Dammann** and Mme. **Hée**: Study of the propagation of the La Courtine explosions.—E. F. **Terroine**, Mlle. S. **Trautmann** and R. **Bonnet**: The energy yield at the expense of the carbohydrates in the growth of the higher plants.—L. **Emberger**: Cytological observations on the bulb of *Lilium candidum*.—M. **Couvreux**: New observations on the photomotor reflex.—P. **Vlès**, P. **Reiss** and E. **Vellinger**: Potentiometric measurements of the P_H of the substance of the eggs of the sea-urchin. For the crude egg substance, the P_H appears to be between 5 and 5·5 before loss of carbon dioxide; it rises to about 6·2 when this gas has been eliminated.—Ch. **Dhéré**, A. **Schneider** and Th. **Van der Bom**: The photographic determination of the fluorescent spectra of hæmatoporphyrine in various solvents.—J. **Régnier**: The variation of the anæsthetic power of cocaine hydrochloride as a function of the proportion of hydrogen ions. The rapidity of anæsthesia is much more rapid for alkaline than for acid solutions. With high P_H, anæsthesia is complete in two minutes.

August 11.—M. Guillaume in the chair.—A. **Lacroix**: The meteoric irons of Senegal and the Sahara.—A. A. **Guntz**: The energy set free in phosphorescence.

CALCUTTA.

Asiatic Society of Bengal, August 6.—Satya Churn **Law**: *Parus major cinereus* breeding in the 24 Perghanas. Two instances of the breeding of this

bird in the suburbs of Calcutta in the district of 24 Perghanas are recorded. Hitherto there was nothing on record about its nidification in this district.—Satya Churn **Law**: Kālidāsa and the migration of birds. Migration may not have been understood by Kālidāsa, but the phenomenon itself did not escape him. Scattered about in his works are passages which unmistakably refer to this peculiar feature of bird-life, and there are many expressions relating to birds which can be explained only with reference to the migratory phase of their life.—Bisvesvar **Bhattacharyya**: The age of the Padmā. Literary and historical argument in support of the thesis that the Padmā or lower course of the Ganges grew to its present size not during the 16th century A.D., as commonly held, but perhaps during the 14th, or even 13th, century.—Bimala Charan **Law**: The Aśmakas or Assakas in ancient India. A discussion regarding the name and origin of the Assaka tribe and a brief account of its traditional history as may be gleaned from Brahmanical and Buddhist literature.—J. H. **Hutton**: Some carved stones in the Dayang Valley. Descriptive of a little-known group of carved menhirs at Kasomari-pathar near Jamugiri, hitherto only known from a brief description by Bloch in 1905. A connexion may exist between the stones and surviving ceremonies of the Naga tribes.—A. **Grignard**: Our Romanised Hindustani-English dictionaries: their partial inefficiency and its remedies.—Lily **Strickland-Anderson**: Some notes on the customs of the Khasi people of Assam.

Official Publications Received.

Meddelanden från Statens Meteorologisk-Hydrografiska Anstalt. Band 2, No. 2: Malarens Isforhållanden vintrarna 1917/18–1921/22. Av J. V. Eriksson. Pp. 20+4 plates. 3 kr. Band 2, No. 3: Nederbördskartor över Sverige. Av Axel Wallén. Pp. 8+3 plates. 2 kr. (Stockholm.)

Abisko Naturvetenskapliga Station. Observations météorologiques à Abisko en 1922. Faites et rédigées par Bror Hedemo. Pp. iv+66. (Stockholm.)

Statens Meteorologisk-Hydrografiska Anstalt. Årsbok, 4, 1922. 3: Vattenstånden vid Rikets kuster. Pp. 25+5 plates. 4 kr. Årsbok, 5, 1923. 2: Nederbörden i Sverige. Pp. 172+1 plate. 5 kr. (Stockholm.)

U.S. Department of Agriculture: Weather Bureau. Cloud Forms, according to the International System of Classification. Pp. 22. (Washington: Government Printing Office.)

Twickenham Public Library. Thirtieth Report, 1923–24. Pp. 12. (Twickenham, Middlesex.)

Technical College, Bradford. Prospectus of Part Time Courses. Prospectus, Session 1924–25. Pp. 192+26 plates. (Bradford.)

Northampton Polytechnic Institute, St. John Street, London, E.C. Announcements, Educational and Social, for the Session 1924–1925. Pp. 240+4 plates. (London.)

London County Council. Lectures and Classes for Teachers: Handbook for the Session 1924–25. Pp. 74. (London: County Hall, S.E.1.)

Agricultural Experiment Station of the Rhode Island State College. Bulletin 197: The Examination of Eggs from Infected and Immunized Hens, with Germicidal Tests on Albumen and Blood Serum. By Henry G. May. Pp. 47. (Kingston, R.I.)

The Cordwainers Technical College, Eagle Court, St. John's Lane, E.C.1. Prospectus of Classes in Boot and Shoe Manufacture and Making, Leather Goods Manufacture and Leatherware Art Work, Day and Evening Classes, Session 1924–5. Pp. 43. (London.)

Southern Rhodesia Geological Survey. Short Report No. 16: Interim Report on the Geology of the Country South of Umsweswe, Hartley District. By A. M. Macgregor. Pp. 18. (Salisbury, Southern Rhodesia.)

The Animal Products Research Foundation of the University of Adelaide. Third Annual Report, 1923. Pp. 4+21+3+9+12. (Adelaide.)

Queensland. Department of Mines: Queensland Geological Survey. Publication No. 273: Mesozoic Insects of Queensland. By Dr. R. J. Tillyard and B. Dunstan. Part 2. By R. J. Tillyard. Pp. 175-506+19 plates. (Brisbane: A. J. Cumming.)

The British Dyestuffs Industry 1856–1924. A Booklet issued by the British Dyestuffs Corporation, Ltd., on the occasion of the British Empire Exhibition, 1924. (Manchester: 70 Spring Gardens.)

British Empire Exhibition, Wembley. The Imperial Institute Exhibit in the Pavilion of His Majesty's Government. Pp. 30. (London: Imperial Institute.)

Department of Commerce: Bureau of Standards. Scientific Papers of the Bureau of Standards, No. 490: Spectra and Critical Potentials of Fifth Group Elements. By Arthur E. Ruark, F. L. Mohler, Paul D. Foote, and R. L. Chenault. Pp. 463-486. (Washington: Government Printing Office.) 10 cents.

United States Department of Agriculture. Department Bulletin No. 1218: Horse-Flies; Biologies and Relation to Western Agriculture. By J. L. Webb and R. W. Wells. Pp. 36+4 plates. (Washington: Government Printing Office.) 10 cents.

Board of Education. Report for the Year 1923 on the Science Museum. Pp 20. (London: H.M. Stationery Office.) 9*d.* net.

Experimental Researches and Reports published by the Department of Glass Technology, The University, Sheffield. Vol. 6, 1923. Pp. 230 (Sheffield.)

Contributions from the Princeton University Observatory. No. 6: Photometric Researches. The Eclipsing Variables Y Camelopardalis, S Z Herculis, R S Vulpeculæ, R Canis majoris, R Y Aquarii. By Raymond Smith Dugan. Pp. 66. (Princeton, N.J.)

Smithsonian Institution: United States National Museum. Bulletin 99: East African Mammals in the United States National Museum. By N. Hollister. Part 3: Primates, Artiodactyla, Perissodactyla, Proboscidea, and Hyracoidea. Pp. viii+164+57 plates. 40 cents. Bulletin 104: The Foraminifera of the Atlantic Ocean. Part 5: Chilostomellidæ and Globigerinidæ. By Joseph Augustine Cushman. Pp. v+55+8 plates. 15 cents. (Washington: Government Printing Office.)

Department of the Interior: Bureau of Education. Bulletin, 1924, No. 2: Industrial Schools for Delinquents, 1921–22. Prepared by the Division of Statistics of the Bureau of Education under the Supervision of Frank M. Phillips. Pp. 22. (Washington: Government Printing Office.) 5 cents.

Smithsonian Institution: United States National Museum. Contributions from the United States National Herbarium. Vol. 22, Part 7: The North American Species of Aristida. By A. S. Hitchcock. Pp. viii+517-586. (Washington: Government Printing Office.) 10 cents.

Department of the Interior: United States Geological Survey. Water-Supply Paper 520-B: Additional Ground-Water Supplies for the City of Enid, Oklahoma. By B Coleman Renick. Pp. ii+15-26. Bulletin 747: Geologic Literature on North America. By John M. Nickles. Part 2: Index. Pp. 658. 65 cents. Mineral Resources of the United States, 1921. Part 1: Metals. Pp. iv+130A+599-617. (Washington: Government Printing Office.)

Annual Reports of the Academy of Natural Sciences of Philadelphia for the Year ending November 30, 1922. Pp. 98+8 plates. (Philadelphia, Pa.)

Year Book of the Academy of Natural Sciences of Philadelphia, 1923. Pp. 96+9 plates. (Philadelphia, Pa.)

Museums of the Brooklyn Institute of Arts and Sciences. Report upon the Condition and Progress of the Museums for the Year ending December 31, 1923. By William Henry Fox. Pp. 60+3 plates. (Brooklyn, N.Y.)

The Journal of the Royal Horticultural Society. Edited by F. J. Chittenden. Vol. 49, Part 2, July. Pp. 139-304+lxxi-cxxvii. (London: Vincent Square, S.W.1.) 7*s.* 6*d.*

Sir John Cass Technical Institute, Jewry Street, Aldgate, E.C. Syllabus of Classes, Session 1924–1925. Pp. 107. (London.)

Smithsonian Miscellaneous Collections. Vol. 67, No. 9: Cambrian Geology and Paleontology, IV. No. 9. Cambrian and Ozarkian Brachiopoda, Ozarkian Cephalopoda and Notostraca. By Charles D. Walcott. (Publication 2753.) Pp. 477-554+plates 106-126. Vol. 75, No. 1: Cambrian Geology and Paleontology, V. No. 1: Geological Formations of Beaverfoot-Brisco-Stanford Range, British Columbia, Canada. By Charles D. Walcott. (Publication 2756.) Pp. 51+8 plates. (Washington Smithsonian Institution.)

Report for 1923 on the Lancashire Sea-Fisheries Laboratory at the University of Liverpool and the Sea-Fish Hatchery at Piel. Edited by Prof. James Johnstone. Pp. 129. (Liverpool.)

Diary of Societies.

MONDAY, SEPTEMBER 8.

INSTITUTE OF METALS (at Institution of Mechanical Engineers), at 8 P.M.—W. M. Corse: Recent Developments in Non-Ferrous Metallurgy in the United States, with Special Reference to Nickel and Aluminium-Bronze. (Third Annual Autumn Lecture.)

TUESDAY, SEPTEMBER 9.

INSTITUTE OF METALS (at Institution of Mechanical Engineers), at 10 A.M.—R. J. Anderson and E. G. Fahlman: A Method for measuring Internal Stress in Brass Tubes.—D. H. Andrews and Prof. J. Johnston: The Application of the Ideal Solubility Curve to the Interpretation of Equilibrium Diagrams in Metal Systems.—Dr. G. D. Bengough and R. May: Seventh Report to the Corrosion Research Committee of the Institute of Metals.—E. H. Dix, Jr., and Lieut. A. J. Lyon: Comparative Results on Copper-Silicon-Aluminium and other Aluminium Alloys as obtained on Separately Cast Specimens and Specimens cut from a Crankcase Casting.—D. M. Fairlie and G. B. Brook: The Determination of Sodium in Aluminium.—R. Genders: The Extrusion of Brass Rod by the Inverted Process.—Dr. D. Hanson and Grace W. Ford: Investigation of the Effects of Impurities on Copper. Part II. The Effect of Iron on Copper.—D. H. Ingall: The Relationship between Tensile Strength, Temperature, and Cold-Work in some Pure Metals and Single Solid Solutions.—Dr H. Moore: The Effect of Progressive Cold-Rolling on the Brinell Hardness of Copper.—Sir Thomas K. Rose and J. H. Watson: Experiments on the Working of Nickel for Coinage.—F. W. Rowe: (*a*) Some Experiments on the Effect of Casting Temperature and Heat-Treatment on the Physical Properties of a High-Tin Bronze; (*b*) Some Experiments on the Influence of Casting Temperature and Mass on the Physical Properties of Admiralty Gun-Metal.—Tomojiro Tanabe: Studies in the Aluminium-Zinc System.—T. H Turner and W. E. Ballard: Metal Spraying and Sprayed Metal. (A selection of above Papers will be presented in abstract and discussed.)

INSTITUTE OF MARINE ENGINEERS, at 6.30.—J. L. Hodgson: The Measurement of Pressure.

WEDNESDAY, SEPTEMBER 10.

INSTITUTE OF METALS (at Institution of Mechanical Engineers), at 10 A.M.—(A selection of the Papers given above will be presented in abstract and discussed.)

NATURE

SATURDAY, SEPTEMBER 13, 1924.

CONTENTS.

Editorial and Publishing Offices :
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.

Telephone Number: GERRARD 8830.
Telegraphic Address: PHUSIS, WESTRAND, LONDON.

Science and Religion.

THE assembly of the Conference of Modern Churchmen at Oxford at the end of last month, and the adoption of the subject "The Scientific Approach to Religion" as the theme of the discussions, seem to suggest the present as an opportune moment for reconsidering the old question of the relation between scientific and religious doctrine. The atmosphere of this clerical conference was totally different from that of other ecclesiastical congresses where scientific questions have been under discussion. There was an almost complete absence of traditional presuppositions —in fact, there seemed to reign a determination to get back to first principles, and build upon the same foundation as that on which scientific teaching is based, namely, the ultimate nature of things—in a word, the structure and meaning of the universe.

The functions of religion and science are different both theoretically and practically, but it seems to us that both are equally necessary for the welfare of the human race. Religion differs in its theoretical aims from science, because the aim of science is the constant pressing forward to the discovery of new truth, whilst that of religion is the holding fast and transmitting to posterity of truth that has already been ascertained. On the practical side, the object of science is to adapt man ever more closely to his environment, and, so far as he can master it, to adapt the environment to him, whilst that of religion is to furnish the sanctions for the laws which hold society together. It may perhaps be objected that the delights of scientific investigations are able to support the man who pursues them in all the troubles of life without any assistance from religion whatever. This is undoubtedly true, but it does not carry us very far. For scientific work is impossible except in the environment of a civilised society, and the carrying on of such a society implies the performance of a great deal of monotonous and uninteresting work. The attempt to crush religious belief, and thus to persuade those who perform this work to persevere in the absence of the comfort and hope supplied by the Church, has proved a disastrous failure every time that it has been attempted. We have just witnessed the last of these attempts, that of the Bolshevists in Russia, which has resulted in consequences patent to all the world.

The conference was opened by an address by the president, the Very Rev. W. Inge, Dean of St. Paul's, who is distinguished above most other Churchmen by his knowledge of and sympathy with science, and it was closed by a sermon delivered by Canon Barnes, Bishop-designate of Birmingham, who was an eminent

scientific man and a fellow of the Royal Society before he entered the service of the Church.

If religious beliefs are founded on an ineradicable element in human nature, then nothing can be more disastrous than an irreconcilable cleavage between these beliefs and the teachings of science. It is, as Dean Inge said, an "open sore," and he added that to contribute in some measure to the healing of the sore was the main object of the conference. But religious truth is necessarily expressed in terms of the "Weltanschauung" of the period at which it was first promulgated. This "Weltanschauung" is just the science of the time, and as it becomes changed the religious truth is left embedded in a setting of outworn ideas. The aim, therefore, of the reconciler must be to extract the "timeless element" in religion from this setting and express it, so far as possible, in a pure and unadulterated form. This element Dean Inge finds in the "values"—goodness, truth, and beauty. These he declares to be the most real things in the universe: from their permanence he deduces not only the existence of God in whom they are completely realised, but also the permanence of those elements in us which respond to these values and seek for their complete expression.

Profs. Haldane and MacBride were invited to the conference as respectful and sympathetic outsiders, in order to state as clearly as possible the modern positions on vitalism and evolution. Prof. Haldane emphatically asserted that the action of living beings cannot be explained upon mechanical principles—it is theoretically possible to construct a series of imaginary machines the working of which will simulate more or less closely the actions of living beings; but as our knowledge of the details of these actions grows, so the machines become more and more complicated—and the futility of the whole procedure is shown by the fact that no account whatever can be given of the "mechanism" by which these machines come into being or how these supposed intricate structures emerge from the egg. Prof. MacBride pointed out that the acceptance of evolution necessitated the entire recasting of the Mosaic cosmogony and of the doctrines of sin and the fall set forth by St. Paul, and he also directed attention to the great outstanding difficulty in the way of any theory of a beneficent Author of the universe, namely, the cruelty and carnage involved in the elimination of the unfit. On the other hand, whilst giving a résumé of the well-known evidence for animal evolution, Prof. MacBride pointed out that "natural selection" gives no explanation of the process any more than the pruning-knife can account for the forces of growth in the plant; that the driving force of evolution is the power of the living being to rise up to meet adverse circumstances and, by adapting itself to them, to overcome them; and that the powers acquired by the parents are transmitted to the children. Evolution, therefore, in the proper sense, is a vital phenomenon which can be exhibited only by living beings, and to use it to include the physical and chemical processes involved in the cooling of a heated globe, for example, as did Herbert Spencer, is to empty it of its essential meaning. In principle, therefore, Prof. MacBride and Prof. Haldane agreed.

The president in his opening address had touched on the limitations of scientific explanations. Science knows nothing of origins or ends but only of processes. In a rigidly defined mechanical system, change and adaptation are impossible; moreover, if the cosmos as a whole is regarded as a mechanical system, then it is not self-explanatory, for it is not a static system but is "running down." No reason can be assigned why it should not have already reached equilibrium if we postulate an indefinite period of past time. There must be something permanent behind it—and this something which the religious soul quests for, and to which it believes itself to be akin, is God. Prof. De Burgh's paper connects at this point with Dr. Inge's address; for he dealt with the stupendous subjects of God, time, and eternity. In a most brilliant essay he pointed out that the idea of time as a mere flux of vanishing "nows" is inconceivable and self-contradictory—that there must be a permanent basis underlying it, and this permanent basis he identified with eternity. He thought that whilst an "Absolute" of some kind was a necessary postulate of reason, we required the religious experience to convince us of the existence of God. This we think rather dangerous reasoning. The word "God" is just the name given by the plain man to the reality behind the complex of circumstances surrounding him, by which he is limited and controlled. He is conscious of strong desires, and conceives purposes in the execution of which he is frequently frustrated; therefore in the world around him there is an "other" to which he is frequently opposed. On any theory of evolution his own nature and personality have somehow been evolved out of this "other." Can the stream rise higher than its fountain? "He that planted the ear shall He not hear?"

Of course, it may be objected that these searches for the ultimate, these aspirations after union with the divine, can never give us anything but pleasant dreams, whereas science supplies us with solid facts on which we can depend. This contrast between the certainty of science and the vagueness and uncertainty of religion sounds obvious, but we are not at all sure that it will stand critical examination. After all,

what are "facts"? "The ordinary man," said that acute philosopher McTaggart, "thinks that he knows facts; but when we analyse these 'facts' they turn out to be a compound of sensations and thoughts." It is vain for the physiologist to point out that consciousness appears in Nature as a mere epiphenomenon associated with the chemical changes in certain organic compounds. When he uses reasoning like this, he implicitly separates his own reason and perception from the rest of the world, and views the workings of other conscious beings from the outside. "I cannot conceive of matter," said the candid Huxley, "apart from mind to picture it in." To quote another Cambridge philosopher: "From one point of view consciousness appears a temporary phenomenon associated with certain forms of matter, but when we look at it from another point of view it swallows everything else. Both views are true, and we do not realise what a wonderful universe we dwell in till we have grasped this fact."

Religion is sometimes regarded from the evolutionary point of view as a defence mechanism which has been brought into being to support and encourage the communal life of the tribe, but reason and its product scientific knowledge may, with equal justice, be regarded as a food-getting mechanism evolved to enable us to feed ourselves, and in no way to be considered as capable of giving us accurate information about the universe. Indeed, if we for a moment assume the validity of our own sensations and view our fellow-man from without, what ground have we for supposing that his sensations will give him any accurate picture of the world around him? How can a vibration in the ether impinging on a retinal cell and setting up therein chemical changes which result in the "stimulation" of a nerve cell, and the transference of this "stimulation" to the brain, give any information as to the nature of the body from which the vibration proceeded? Yet, if we do not make this assumption, there is an end to science. If we, therefore, following our natural instincts, trust our senses to tell us what the universe is like, why should we not trust our religious instinct as to the kinship between our own spirits and the Ultimate Reality? The question, therefore, of the "validity" of our knowledge must be separated from all speculations as to its evolutionary origin.

The fundamental difficulty of the whole situation is that the man of science and the philosopher alike strives each to construct a complete system to include the whole universe. The humbler and more correct attitude is that of Huxleyan agnosticism, which, as Prof. MacBride pointed out at the conference, is entirely compatible with the Christian faith; for this faith is a determination to stake everything on the hope that the "values" will turn out to be real and eternal. In the obituary notice of Huxley published in NATURE and written by his pupil, Sir Michael Foster, there appears the sentence, relating to the problem of the survival of the soul, "Huxley was convinced that science could never with all its endeavours avail to raise one corner of the veil concealing that dream by which our life is rounded."

Perhaps we may best sum up the whole matter in the words of that scientific theologian, Harnack:

"In spite of intense effort our modern thinkers have not succeeded in developing a satisfactory system of ethics and one corresponding to our deepest needs on the basis of monism. They will never succeed in doing so. If this be admitted it is in the last resort a matter of indifference with what names we designate the two sides of the dualism which, as moral and thinking men, we encounter—for instance God and the World, Here and Hereafter, Visible and Invisible, Matter and Spirit, Necessity and Freedom. Unity can be *experienced* and one side can be subordinated to the other, but this unity is always reached by a struggle in the form of an endless problem which can only be approximately solved, and never by the refinement of a mechanical process. We are not able to bring our knowledge of time and space into the unity of a consistent Weltanschauung with our inner life. Only in the peace of God which is higher than all reason can we catch a glimpse of their ultimate unity."

The Rarer Elements.

Chemistry of the Rarer Elements. By Prof. B. Smith Hopkins. Pp. vii + 376. (Boston, New York, Chicago, and London: D. C. Heath and Co., 1924.) 15*s*. net.

THE reader's interest will be aroused even before he has opened this volume; for he will doubtless be curious to learn which members of the elemental series the author has decided to group together under the rubric of "rarer elements." The preface furnishes a satisfactory definition. Prof. Hopkins has taken as his province "those elements which are little known either because of scarcity, neglect, or ignorance." His object has been "to call attention both to the advances which have recently been made in our knowledge and also to the need of further research in the development of many of the less familiar elements."

It must be confessed that, to the non-specialist, many of the books hitherto written about the rarer elements are more than a little dry. Before opening them, the would-be reader has a foreboding—often justified in the event—that he will find within the covers simply the usual accumulation of facts carefully grouped under certain set headings: facts, individually

important, which seem to resist any attempt to force them into any far-reaching and logical scheme. This apparent incoherence of the data attains its culmination in the case of the rare earth group, where, although the proper elemental sequence is indisputable, no generally accepted system has yet been evolved which will bring the elements into line with each other or with the remaining forms of matter which we know.

There is another pitfall in the path of a writer upon the rarer elements. Owing to the fact that he is making an arbitrary selection from the material, he runs a grave risk of isolating the elements with which he deals from their commoner brethren; and in this way he tends to produce the impression that these rarer elements stand in a class by themselves, that gallium, for example, is in some mysterious way to be mentally segregated from the remainder of its group.

Prof. Hopkins's book avoids both of these difficulties. He gives the reader a general description of the salts of each of the elements with which he deals; but he has resisted the temptation to insert data simply because they are known. The result is that his book holds the reader's interest without difficulty, even in those places where dulness might be expected to supervene.

Even more praiseworthy is the fact that he never allows the student to forget the relations existing between the elements as a whole and the particular one which is under discussion. The book opens with a chapter on the Periodic System, in which some of the recently suggested forms of the Periodic Table are described and the possibility of further discoveries of new elements is examined. This forms the frame into which the rarer elements are fitted one by one. But, in addition to this, each section of the book is headed by an excursus in which a general survey is made of the group containing the special rare elements under discussion in that section. Thus the peculiar mental partition between the "rarer" elements and the "commoner" elements is never allowed to grow up in the mind of the student.

Another feature which makes the book specially valuable to the student is the way in which the practical importance of the rarer elements is emphasised in detail; for in some books the impression is left that these substances are mainly of academic interest. Prof. Hopkins, without overloading his pages, has succeeded in tracing the ramification of these rarer elements into commercial practice; and his chapters cannot fail to suggest that we are as yet only on the frontier of a great development. As a rule, the author deals in turn with the history of the element, its occurrence in Nature, its extraction and metallurgy, its properties, its uses, and he terminates his sections with brief descriptions of the more important compounds and the methods whereby they may be identified.

The publication of books of this type seems to be one of the hopeful features of modern chemical literature. In the past there was an appreciable gap between the college text-book on one hand and, on the other, the German compendium in six or more volumes which generally, with quite unconscious humour, was entitled a "Hand-book"; and the student who had just mastered the elements was apt to be intimidated when faced with his next step in the literature of his subject. Nowadays, with excellent series of monographs from British and American publishers, the student is much better off. He can get his information on certain subjects without having to wade laboriously through huge systematic "text-books." Thus he is able to attain a reasonable standard of knowledge without being discouraged by the forced realisation of how much he does *not* know; while at the same time his interest is sharpened and he is encouraged to go forward in the pursuit of a more complete knowledge. Chemistry, with all its modern ramifications, has long passed the stage when any one except the mere book-worm can pretend to "know" the whole of it in detail; and the recent trend in chemical literature away from the cast-iron systematic text-book has been all in the interest of the student who has just completed his course and is looking forward to extending his knowledge. Books like this of Prof. Hopkins are to be welcomed. A. W. S.

Geology of the United States.

A Text-Book of Geology: for Use in Universities, Colleges, Schools of Science, etc., and for the General Reader. By Prof. Louis V. Pirsson and Prof. Charles Schuchert. Part 2: *Historical Geology.* By Prof. Charles Schuchert. Second, revised edition. Pp. ix + 724. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1924.) *22s. 6d.* net.

ORIGINALLY published nine years ago, Pirsson and Schuchert's Text-book has become the most popular introduction to geology among American students, and its well-merited supremacy is now likely to be still more firmly established by the issue of a second edition in which it has been thoroughly revised and brought up-to-date. The first volume, by the late Prof. Pirsson, deals with physical geology and is naturally of wider interest than the second part—now under review—in which Prof. Schuchert lucidly sets forth the principles of stratigraphy and palæontology, and the broader features of the geological history of

the United States. Compared with its first edition, the second volume is now increased by about eighty pages, a series of palæogeographical maps have been introduced, and the Ozarkian has disappeared as a system, the formations known by that name being now regarded as the closing epoch of the more familiar Cambrian. Eozoon is still thought to represent the earliest known evidence of calcareous algæ. As in the first edition, there are no detailed references, but this defect is met by appending to each chapter a list of suggestions for further reading. It is worthy of notice that British work has not been neglected as it so often is in American books. Moreover, the Period names are retained for the most part in their original forms, and such terms as "Permic" are happily given no support.

The treatment of the work as a whole is very much broader than the title indicates, for interspersed with the stratigraphical chapters there are just as many dealing with palæontology. These, with others of general interest, on such topics as astronomy, biology, and evolution, make up a composite course of about forty-five lectures.

In teaching historical geology, it is logically but unfortunately necessary to plunge straight away into the intricate labyrinth of the Archæan; to start as closely as possible to that vague "beginning" of which Hutton could find no certain trace. The difficulty is one, however, that can be fairly met and overcome. But sound scientific method becomes impossible when the subject is made to begin with the origin of the earth and its "pre-geological" history. These are problems that belong more properly to geophysics, problems which will be attacked with success only when the earth's age, its thermal history, the origin of the continents, and other fundamental questions have been solved with a greater degree of confidence than is yet possible. It will nevertheless be refreshing to British readers to find that the influence of the planetesimal hypothesis and of its author's more personal opinions is now apparently steadily waning. This is mainly the result of criticisms by Daly and Barrell, the latter, before his lamented death, having clearly influenced the teaching of the book. Although no mention is made of the work of Harold Jeffreys (whose new book on geophysics leaves no excuse for that omission in future), the conclusion that the earth must have passed through a fluid state is accepted for other reasons.

A very interesting chapter deals with the perennial question of the permanency of the continents, but the problem of their origin is not solved by the speculations offered. The difficulty is essentially to explain the lateral differences of density between the lighter continental and the heavier oceanic segments of the earth's crust. It is suggested that heavy flows of widespread magma broke through the crust over wide areas and caused them to subside into ocean basins; but unless the magmas were very much more dense than we have any reason to suppose, the new surface would be no lower than the original one, and the vertical distribution of densities would be unstable in a way that should since have disclosed itself in the petrology of the oceanic igneous rocks. Pushing the light rocks down to great depths does not solve a problem, which is one of lateral, not vertical, differences.

Other general chapters deal with coal, petroleum, geological climates of the past, man's place in Nature, and the age of the earth. Joly's recent views based on pleochroic haloes are referred to but not accepted. Schuchert concludes that the hour-glass of denudation and sedimentation has not been read correctly by the majority of geologists in the past, and that the earth is at least 500 million years old.

Regarded as a college text-book, perhaps too much space is devoted to speculative matters and not enough to the economic resources of the systems or the igneous history of the continent, though these aspects of the subject are by no means wholly neglected. The stratigraphical chapters naturally take their main inspiration from the country of the author, and little attempt is made to correlate with Europe. The appeal of the book is therefore limited from the point of view of the British student, for whom, indeed, it is unsuitable as a text-book. It is, however, full of ideas for teachers of the subject; it may be confidently accepted as the most up-to-date and authoritative summary of the geology of the United States; and it is consequently worthy of a place in every reference library.

Arthur Holmes.

Co-ordination of Numerical Data.

The Calculus of Observations: a Treatise on Numerical Mathematics. By Prof. E. T. Whittaker and G. Robinson. Pp. xvi+395. (London, Glasgow and Bombay: Blackie and Son, Ltd., 1924.) 18s. net.

A SET of numerical data, whether obtained from theory or experiment, gives rise to mathematical problems of interest and importance. The consideration of these problems now forms an important branch of pure mathematics: apart from this, some knowledge of them is required by workers in many fields —astronomers, meteorologists, physicists, engineers, naval architects, actuaries, biometricians, and statisticians. Until recently the subject has received but little attention in the mathematical departments of

British universities. During the last ten years, however, interest in it has been thoroughly aroused, especially in the Universities of London and Edinburgh. To Prof. Karl Pearson, head of the Department of Applied Statistics at University College, London, is due the credit of organising a mathematical laboratory for dealing systematically with numerical problems. During the War, Prof. Pearson's laboratory was occupied with numerical work on ballistics: more lately it has produced a series of tracts on computation. In Edinburgh, Prof. E. T. Whittaker has also organised a mathematical laboratory, and the volume before us may be regarded as a manual of the methods that have been evolved there.

The first four chapters, on interpolation and difference formulæ, are also published as a separate tract under the title "A Short Course in Interpolation" (price 5*s.* net). To a mathematician this section is much more convincing than those accounts of the subject which aim primarily at the application of interpolation to engineering or actuarial work. In particular, the important chapter on divided differences has not, we think, appeared before in any English book. Some of the early worked examples involve fifteen-figure numbers, and seem unnecessarily heavy: all the principles at stake could be amply illustrated by numbers of seven or eight digits.

The long sixth chapter gives an account of many useful methods of obtaining the numerical solution of an algebraic or transcendental equation. In numerical work, Horner's process of successive approximation is often found to be less useful than the root-squaring method of Graeffe. Graeffe's method, unlike Horner's, is easily adaptable to the location of complex roots—a problem the importance of which has greatly increased of late through its occurrence in determining the stability of an aeroplane. When an algebraic equation has only one or two pairs of complex roots, Graeffe's method is sufficient to isolate them without difficulty. A recent modification of the method, due to Prof. Brodetsky and Mr. Smeal, enables any number of complex roots to be located: we hope that this discovery will be added to the next edition of the work under notice.

Only the first seven chapters will normally be read as part of a university undergraduate course. A separate volume containing this part of the work alone would appeal to a wide class of readers. The rest of the book, from Chapter viii. onwards, forms an introduction to the mathematical theory of statistics, which, normally, will be read only by graduates engaged on research. Compared with the first seven chapters, this part of the work is too heavy, and the introductory matter leading up to it is inadequate.

When the Edinburgh laboratory was founded in 1913, a trial was made, so far as possible, of every method which had been proposed for the solution of the problems under consideration, and many of these methods were graphical. During the ten years that have elapsed since then, the graphical methods have almost all been abandoned, as their inferiority has become evident, and at present the work there is almost entirely arithmetical. No previous book in any language contains the matter collected here after ten years' experience of dealing with numerical data. The authors are to be heartily congratulated on successfully producing a book that gives the result of so much pioneering work.

W. E. H. B.

Our Bookshelf.

Emergency Water Supplies for Military, Agricultural, and Colonial Purposes: Based on Experience of the Mediterranean Expeditionary Force Operations, with Special Reference to the use of Drive Tube Wells and Drilling. By A. Beeby Thompson. Pp. xii + 180 + 45 plates. (London: Crosby Lockwood and Son, 1924.) 21*s.* net.

POSSIBLY no problem is of such vital importance to the pioneer and settler as that of the location of a suitable source of water supply for drinking and potable purposes; scarcely less inevitable is the problem in connexion with military incursions into countries which are destitute of uncontaminated surface supplies and ill-suited for overland transport. Therefore, to all classes of adventurers and explorers, whether prospecting, colonising, or expeditionary, Mr. Beeby Thompson's book, with its valuable record of methods and contrivances used in connexion with the Mediterranean Expeditionary Force operations, will come with welcome interest, affording much practical precept and useful advice.

Upon diviners or dowsers, Mr. Thompson looks with sceptical eyes. He allows some to be honest, but is frankly suspicious of them all and their methods. Their inconsistencies, not less than their failures, fill him with distrust; yet he is not above letting them have a trial. "In the absence of any definite scientific reason for locating a well at a particular spot, the dowser could be given his chance, and to the author's knowledge the location of small supplies has resulted on several occasions." Mr. Thompson is certainly fair.

The book proceeds, however, on a more scientific basis than any which governs the dowser in his prognostications. The origin of water is discussed, the incidence of rainfall, the amount of run-off, the level of water tables, sources of potable water, and the value of hygienic measures; and thereafter follows a series of chapters on the driving of tube wells, drilling operations, pumping equipment and water analysis, with illustrations from actual experience in Bulgaria, Serbia (why does the author write Servia ?), Macedonia, and elsewhere. Full of practical direction and experimental information, the book should be a valuable guide to all

who seek water supplies in unexplored or undeveloped regions.

Mr. Thompson comments on a fact which he states attracted notice and inquiry during the War, namely, "the comparative permanence of springs high up on mountain ranges after long periods of drought when those lower down commenced to fail," and he advances five reasons, separately or collectively, to account for the phenomenon. It would be interesting to know the extent to which this characteristic was observed and whether it was so general as to be really remarkable.

BRYSSON CUNNINGHAM.

The Plant Alkaloids. By Dr. T. A. Henry. Second edition. Pp. viii + 456 + 8 plates. (London: J. and A. Churchill, 1924.) *28s.* net.

WHEN Dr. Henry published the first edition of his "Plant Alkaloids" ten years ago, general satisfaction was felt and expressed at the appearance in English of a really comprehensive work on so important a subject, and at the masterly way in which the author had dealt with it. Since then, notwithstanding the general interruption of such work due to the War, many investigations have been made and many researches published on the isolation, constitution, and properties of the alkaloids. One need only mention such examples as the investigation of the alkaloids of ergot, opium, areca nut, pomegranate bark, belladonna, cinchona, Calabar bean, ipecacuanha, yohimbe bark; of the oxidation products of brucine by Leuchs and his collaborators, of the constitution of chelerythrine by Karrer, of chelidonine by Gadamer, and so on, to realise the immense amount of material that Dr. Henry had to examine critically and sift in the preparation of the second edition of his work. He has succeeded admirably. Researches published in the spring of this year have received attention, although it may not have been possible for him to deal with them so fully as he may have desired.

Notwithstanding the large amount of fresh material to be dealt with, the size of the volume has not been increased, as that which had been superseded has been omitted as unnecessary. Methods of determining the percentages of alkaloids in drugs have received rather less attention than formerly, and rightly so; indeed, it is rather to be doubted whether these could not in the future be relegated entirely to the books that make such assays the subject of special attention. On the other hand, rather more space has been devoted to the discussion of such information as is available on the relation of chemical constitution to pharmacological action, a subject of surpassing interest but one in which it is not yet possible to draw general conclusions. The six pages given to the pharmacology of the tropane group is a good example of the clear and concise manner in which the author deals with this difficult problem.

Dr. Henry is to be congratulated on the successful accomplishment of his task. All who are interested in plant chemistry in general, or in the plant alkaloids in particular, will be glad to have at their disposal a work of reference that is thoroughly up-to-date and as trustworthy in its information as it is possible for such a work to be.

Handbook of the British Flora: a Description of the Flowering Plants and Ferns Indigenous to, or Naturalised in, the British Isles; for the Use of Beginners and Amateurs. By George Bentham. Revised by Sir J. D. Hooker. Seventh edition, revised by Dr. A. B. Rendle. Pp. lxi + 606. (London: L. Reeve and Co., Ltd., 1924.) *12s.* net.

THE publication of a new edition of Bentham's "Handbook of the British Flora" is of considerable importance to students and teachers of botany in Great Britain. There is no published work which better serves as an introduction to the British flora than this, and, though it can be strongly urged that we now need a completely new "Handbook," approximately on the lines of Schinz and Keller's "Flora der Schweiz," it is a good thing that the republication of Bentham and Hooker's Handbook has not been undertaken without a revision.

Dr. Rendle has most decidedly improved the work, and in many respects has made it more in accordance with modern knowledge and usage. The nomenclature now approximates—after allowing for very considerable differences in species standards—closely to that of Babington's "Manual" (10th edition). The chapter in the introduction on vegetable anatomy and physiology has been omitted, the etymology of generic names and indications of pronunciation have been added, while certain improvements have been made in classification, particularly of the Cryptogams. Descriptions of the relatively few additions, since the last revision, of "Benthamian species" to the British flora are inserted, and bibliographical references are given to some of the more important recent researches on the critical genera. In spite of these improvements, it seems a pity that the very "large" species standard has been retained even for the use of "beginners and amateurs." Modern field-botany tends so much towards ecology, and systematists often feel that the determination of species by ecologists is none too critical, that the need of a handbook with complete keys and adapted for field-work, but based on a conception of smaller, and often more actual, species, is greater than ever.

La Photographie des couleurs. Par Prof. J. Thovert. (Encyclopédie scientifique: Bibliothèque de Photographie.) Pp. viii + 300 + 4 planches. (Paris: Gaston Doin, 1924.) 17·60 frs.

THE photography of colour is a subject that has been gradually growing in importance and extent during the last few decades, so that the time has come when it may well be treated of in more detail than is possible in moderate-sized manuals of photography in general. This volume is therefore a welcome addition to photographic literature. The author deals first with light and colour, including the transmission, refraction, diffraction, interference, and absorption of light, the production of spectra and their uses, and wave motion. The reproduction of colour by interference, dispersion, and by three-colour and two-colour methods follows, with practical instructions and theoretical considerations. Processes that have only a classic or historic interest are treated of sufficiently, but the special adaptation of methods to photomechanical processes is not included. The book is well and usefully illustrated, and has four good plates in colour.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Assignment of Lines and Term Values in Beryllium II and Carbon IV.

WE have already published briefly the methods by which we have recently been able to determine with certainty the degree of ionisation of the atoms giving rise to many of the lines of the spectra produced by our "hot sparks," and in the case of Boron III the method by which the "Term Values" have been worked out (Proc. Nat. Acad., May 15, 1924. See also forthcoming articles in *Physical Review* and *Phil. Mag.*).

The object of the present note is to make a preliminary report upon the application of the same methods to the determination of the chief characteristics of the spectra of the "stripped atoms" of beryllium and carbon (Be_{II} and C_{IV}).

TABLE 1.
BERYLLIUM II.

Int.	λ I.Å. Vac.	ν Vac.		Term Values.
1	1512·31	66124·0	$(2p_2-3d)$	$4f$ — 27438·5 ± 3
2	1512·45	66117 9	$(2p_1-3d)$	$3d$ — 48826·1 ± 3
1	1776·27	56297·7	$(2p-3s)$	$2p_1$ — 114943·7 ± 3
1	4675·6	21387·6	$(3d-4f)$	$2p_2$ — 114950·3 ± 3
?	3132·086	31927·60	$(2s-2p_2)$	$2s$ — 146877 9 ± 3
?	3131·438	31934·21	$(2s-2p_1)$	$3s$ — 58649·3 ± 3

TABLE 2.
CARBON IV.

Int.	λ I.Å. Vac.	ν Vac.		Term Values.
2	384·4	260166	$(2p-3d)$	$3d$ — 195333 ± 30
1	419·8	238197	$(2p-3s)$	$2p_1$ — 455445 ± 100
4	1548·26	64588·6	$(2s-2p_1)$	$2p_2$ — 455553 ± 100
4	1550·84	64481 2	$(2s-2p_2)$	$2s$ — 520034 ± 100
				$3s$ — 217302 ± 100

With the aid of the foregoing term values, and those which we have already published for stripped boron (B_{III}), it becomes possible to arrange tables for the stripped atoms Li_I, Be_{II}, B_{III}, C_{IV}, precisely similar to those which Pashen and Fowler have arranged for the series Na_I, Mg_{II}, Al_{III}, Si_{IV}. Such tables (3 and 4) follow.

TABLE 3.

$$(Z-s)=\sqrt{\frac{\nu\,.\,n^2}{R}}.$$

(See equation 2, our paper "Some Conspicuous Successes of the Bohr Atom and a Serious Difficulty," forthcoming number *Phys. Rev.*
ν = term value.
R = Rydberg constant.
n = total quantum number.)

	2s.	$2p_1$.	3d.	4f.
Li . .	1·259040	1·020736	1·000437	0·999843
Be. .	2·313884	2·046944	2·001155	2·000200*
B . .	3·339489	3·064008	3·001886	3·000431
C . .	4·353908	4·074566	4·002600*	

TABLE 4.

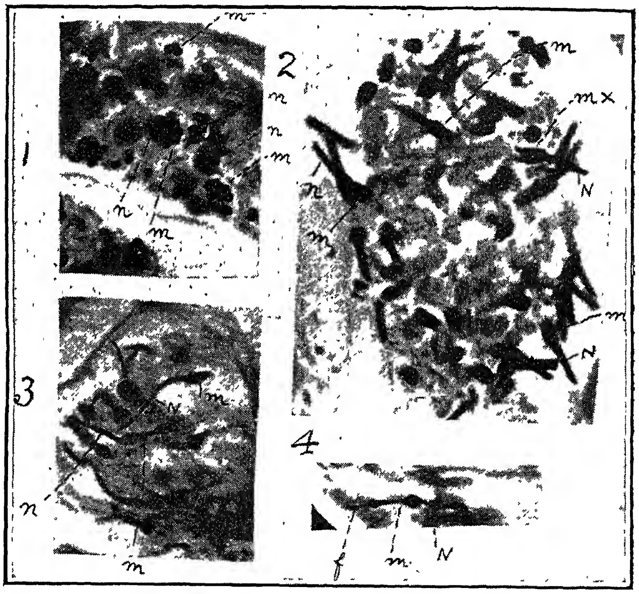
	2s	$2p_1$.	3d	4f.
Li/1 .	43486·3	28582·5	12203·1	6856·1
Be/4 .	36719·5	28735·9	12206·5	6859·6*
B/9 .	33993·1	28616·1	12207·8	6860·2
C/16 .	32502·1	28465·3	12208·3*	
R/n^2 .	27433·0	27433·0	12192·3	6858·3

* Assumed.

R. A. MILLIKAN.
I. S. BOWEN.
Norman Bridge Laboratory of Physics,
California Institute, Pasadena, Calif., July 18.

The Scorpion Spermateleosis.

IN two recent letters to NATURE (July 12 and August 2) Mr. Vishwa Nath has referred to the results obtained by two of my students. Mr. Nath finds himself unable to support the statement of Prof. Bhattacharya and myself, that in the scorpion spermateleosis "the mitochondria form the sperm tail directly." It should be pointed out that the findings of Prof. Bhattacharya and myself directly support the previous work of Prof. E. B. Wilson, the distinguished American cytologist.



So far as we are concerned, our material is very clear and easy to study, and we feel sure that if Mr. Nath examines his slides more carefully, he will find that Wilson has given the correct interpretation of the scorpion spermateleosis.

Herewith we give four photomicrographs of our material. In Fig. 1 the mitochondrial spheres of the spermatids (m), after becoming partially fused, elongate to form a number of leaf-like structures (the mitosome, nebenkern, etc.), shown well at mx in Fig. 2. The nucleus at this stage elongates rapidly (N), while the leaf-like mitochondria further elongate to form a club-shaped structure (Figs. 3 and 4) which eventually, becoming more attenuated, forms the tail as claimed by Wilson. In Fig. 4 the nucleus, N, is partly out of focus, but joins the mitosome at m, and passes back to the axial filament (f), which is embraced by the residual protoplasm containing the Golgi bead.

Moreover, if the mitochondria are rejected, as Mr. Nath's letter suggests, one would expect to find evidence for this in the residual protoplasm, as has been done in pulmonate molluscs (Gatenby). If sloughing occurred at all in the spermatids overloaded with mitochondria, it could only apply to the very tail end, and certainly only after the middle piece had been formed directly from mitochondria.

Both Prof. Bhattacharya and I are hoping to demonstrate our material before the Royal Microscopical Society this winter session We shall be very glad to see Mr. Nath there, and to witness his demonstration of tail formation in scorpion spermateleosis, by any method other than that described by Wilson and Bhattacharya and myself. Our paper on the scorpion spermatogenesis is being published in Prof. Gregoire's Jubilee Number of *La Cellule*.

With reference to Mr. Nath's observations on Miss S. D. King's letter on the "Oogenesis of Lithobius," I should say that Miss King has carried out her investigation under my supervision, and I have examined many of her slides. I feel sure that her account is the correct one. The scheme of oogenesis for Lithobius, worked out by Miss King, agrees with Hogben's previous researches on insect oogenesis, and broadly with my own work on Saccocirrus (Archiannelida).

Mr. Nath mentions that in "Saccocirrus (Gatenby)" the Golgi bodies undergo fatty degeneration. This is incorrect: what I did write was (*Q.J.M.S.* vol. 66, p. 15) that, "From the method and time of appearance of the fatty yolk, I believe it is formed from the Golgi bodies, but I admit it is impossible to make a trustworthy statement in such unfavourable material." The whole point of my Saccocirrus work was that the yolk is nucleolar in origin.

There is one point mentioned by Mr. Nath which is really of interest and value, provided his observations are correct, and I sincerely hope that they are. In a list of animal groups in which the mitochondria directly form the tail, Prof. Bhattacharya and I mentioned (NATURE, June 14): moths (Meves and Gatenby), cockroaches (Duesberg), annelids (Gatenby), scorpions (Sokolow, Wilson, Gatenby, and Bhattacharya), mammals (Duesberg, Regaud, Woodger, and Gatenby, etc. etc.), and certain molluscs also (Gatenby, etc.), and now Mr. Nath states that in his centipede the mitochondria directly form the tail. This is good news to me.

In many of Miss King's Da Fano preparations we found argentophile rings on the sperms. We have not yet worked at the spermateleosis, but I am much interested to read that Mr. Nath also finds Golgi bodies on the tails of the spermatozoa of his specimens. The only spermatozoa hitherto positively known to carry Golgi elements are those of Ascaris and Cavia, but there are other more doubtful cases. It will be curious if later work shows that the argentophile rings of the centipede sperms are really Golgi bodies.

Until Mr. Nath has the opportunity of reading Miss King's full paper, which will appear about Christmas in the Proceedings of the Royal Dublin Society, I feel that further comment will not be of advantage to cytology in general.

J. BRONTË GATENBY.

Trinity College, Dublin,

August 15.

Interpretations of Primitive American Decorative Art.

DR. H. O. FORBES in his communication on "Pre-Columbian Representations of the Elephant in America" in NATURE of August 2, p. 174, makes some statements on which I would like to offer comment. In his attempt to discover a basis in the Cephalopoda for the decorative *motifs* under discussion, Dr. Forbes states (p. 176) that "In the argonaut, the two central arms, when all are spread, are often so closely apposed as to appear a single very broad tentacle—a feature very conspicuous in the South Atlantic Bathypolypus." Now "central" arms can either mean the second and third of each side or possibly the first and last of both sides (the dorsal and ventral pairs). In either case Dr. Forbes's statement is inaccurate, so far as I can judge from the examination of numerous specimens and figures of Argonauta. The arms in question are not thus "closely apposed as to appear a single very broad tentacle." The statement seems to be likewise inapplicable in the case of Bathypolypus. This genus was founded in 1921 by Grimpe. It was not defined by him though he designated the type (*Octopus arcticus* Prosch). A definition prepared by myself, after correspondence with Dr. Grimpe, is in the press at the present moment. This genus includes *Octopus arcticus* Prosch, *faeroensis* Russel, *lentus* Verrill (N. Atlantic), and *grimpei* Robson (M.S.), and *valdiviæ* Thiele (S. Atlantic). It is doubtful at present what others should go into it. In any event, the two South Atlantic species have not the characters attributed by Dr. Forbes to the genus.

I may be doing Dr. Forbes an injustice. I may have overlooked in a recent fairly exhaustive search a large number of species having the character described by Dr. Forbes and transferred to Bathypolypus. If that is the case I should be very grateful for information concerning such cases.

With regard to the suggestion made by Dr. Forbes that the Maya and Copan sculptures can be interpreted as figures of highly conventionalised Cephalopods, I feel that the evidence is insufficient to sustain his theory. I admit that the Manabi slab (Dr. Forbes's letter, Fig. 1, p. 174) looks like a conventionalised squid, though I feel that careful examination would very much modify this preliminary impression (for example, if a squid, why *eight* arms ? ; ? meaning of the four arms or tufts on the "mantle"; ? *circular* ends of arms). With regard to the Tikal lintel (Fig. 2) I confess that I feel a little less compromising. According to Dr. Forbes the central part of this design is a "specialised" (sic !) "argonaut or octopus" with beak and two glaring eyes, etc. I can only say that, if this is a true interpretation, then the artist has thrown the structure of his model to the winds and relied on the most generalised conception. This is no doubt very often done in highly conventionalised art, but the admission weakens any interpretation that relies on the data of realism, as Dr. Forbes does. The "superciliary ridge" from under which the eyes glare out is, according to Dr. Forbes, "the fleshy upper margin of the mollusc's mouth." In other words, the eyes and mandibles of the supposed Octopus, which are in the living animal on opposite sides of the umbrellar membrane, are not only on the same side of the latter in the Tikal lintel but the eyes are also actually placed inside the labial membrane! The structures assumed by Dr. Forbes to be sucker-bearing arms may conceivably constitute a *motif* based on these structures; but the round circles (*sc.* suckers) turn up in this design in places where it is difficult to assign them to any particular arm, so that they may be merely decorative symbols devoid of any natural basis.

While allowing a vague suggestion of a cephalopod *motif* in Fig. 2, I consider such an interpretation quite devoid of basis in Fig. 3, while in the case of the Copan Stela it is not possible to offer any serious comments, as the photographs are not good enough to enable one to form an opinion. Fig. 5 may suggest a squid, though its apical extremity is curved suspiciously like

an elephant's trunk; while one would have thought that alongside the "trunk" in Figs. 5 and 6 there were represented (in a conventionalised fashion) structures that look like tusks.

In conclusion, I should like to say that Dr. Forbes has certainly rendered a service in giving alternative explanations to some of the *motifs* of primitive American art. I do not agree that any of the figures (except possibly that of the Manabi slab) reveal a *whole* cephalopod, though parts of his Figs. 2 and 7 suggest that the arms may have been employed as incidents in larger designs. I feel, however, that unless we can obtain evidence as to the earlier stages from which this very conventionalised and, I venture to suggest, somewhat debased method of design was evolved, a Proboscidean, a Molluscan, or even a Cœlenterate interpretation will be equally plausible.

G. C. ROBSON.

British Museum (Natural History),
August 19.

On the Mercury Line λ2270 A.

IT is a remarkable fact that of the three transitions of an electron in a mercury atom represented by $1S-2p_1$, $1S-2p_2$ and $1S-2p_3$, we see optically only $1S-2p_2$ (λ2536), while the other two, namely, $1S-2p_1$ (λ2270) and $1S-2p_3$ (λ2655), have not been observed at all except by the indirect method of measuring the ionisation by impacts of electrons on atoms by Franck and Einsporn (*Zeit. f. Physik*, ii. p. 18, 1920).

In 1922, at the suggestion of Prof. N. Bohr, one of us, in conjunction with Prof. H. M. Hansen and Dr. S. Werner (Kgl. Danske Videnskab. Selskab. Math.-fys. Medd. v. 3, 1923), tried to find how to make possible the transitions from these two meta-stable states $2p_1$ and $2p_3$ to the normal state $1S$.

As a result, we found that the line λ2270 is excited in a Geissler tube when a condensed discharge is passed, whereas the line λ2655 was not detected at all.

In the present experiment, the account of which will be published later in detail, we tried to get the line λ2270, not in the spark spectrum but in the arc spectrum of mercury.

We found that the arrangement used by Messrs. Metcalfe and Venkatesachar (Proc. Roy. Soc. A, 100, p. 149, 1921; A, 105, p. 520, 1924) for the study of the absorption of mercury lines produces the line λ2270 with considerable intensity. Instead of using the long tube filled with mercury vapour as the source of absorption, we employed it for emission, and by passing a current from 2 to 3 amperes through the long tube, which we might call "a branched arc," we found that the intensity of the line λ2270 could be raised so as to come between $m=8$ and $m=9$ in the diffuse series $\nu=2p_2-md_2$. In other words, the line λ2270 appears stronger than λ2303 ($m=9$), but fainter than λ2323 ($m=8$).

Using the largest size of quartz spectrograph made by Hilger (Littrow type), and photographing in juxtaposition the line λ2270, first as excited in the above method, and second as excited in a condensed discharge, we found that the latter method of excitation gives a shift of about 0·1 A to the red side, with a faint companion line on the red side at a distance of about 0·2 A.

Similar shifts were observed for the line λ2345 ($\nu=2p_3-5s$) in the same sense, but in the opposite sense for the line λ2564 ($\nu=2p_2-4S$). The shifts are not due to the manner of projecting the image on the slit, since there are many lines which show perfect coincidence; neither does it seem likely that the shifts are due to the Doppler effect, as they remain the same when we change the polarity of the condensed discharge, which was fairly well rectified.

No trace of the line λ2655 ($\nu=1S-2p_3$) was observed.

T. TAKAMINE.
M. FUKUDA.

The Institute of Physical and
Chemical Research, Tokyo.

A Rotational "Fatigue" Effect of the Electric Discharge.

IN some recent experiments on the volt-ampere characteristics of low-tension discharge tubes, I utilised an "Osglim" lamp of the "beehive" variety, sealing it on to an apparatus so that air at different pressures could be introduced. (The lamp consists of an iron disc anode and a spiral cathode of thick iron wire, wound above the anode.)

It was observable at certain pressures that, when the discharge was continuous, but failed to cover completely the cathode, the discharge shifted from one part to the other of the cathode surface, often undergoing a regular cycle. At other times the motion was along the wire of the spiral, slowly backwards and forwards through a rotation of up to 120°, and even more. The rotation continued over long periods of time in a most interesting manner.

The phenomenon is apparently an electrode "fatigue" effect. When one portion of the surface has been serving as cathode for some time, it becomes "fatigued," and the value of the cathode fall of potential rises; it then becomes easier for the discharge to pass over at an adjacent portion of the cathode, and consequently the discharge rotates slowly.

That the rotation is accompanied by a corresponding fluctuation of the voltage drop across the tube is evident from the fact that the reading of the voltmeter, across the tube, rises and falls at a similar rate (there is of course a lag), and to a lesser degree variation of the current is observable.

JAMES TAYLOR.

Armstrong College, Newcastle-upon-Tyne,
August 19, 1924.

Zoological Nomenclature: Generic Names for the Official List.

THE following generic names (with genotype in parentheses) have been submitted to the International Commission on Zoological Nomenclature for inclusion in the official list of generic names.

The Secretary will delay final announcement of the votes on these names until January 1, 1925, in order to give to any zoologists, who may desire, the opportunity to express their opinions.

Amphibia: *Cryptobranchus* Leuck., 1821, 259 (*gigantea*=*alleganiensis*=*alleghaniensis*); *Desmognathus* Baird, 1849, 282 (*fuscus*); *Siren* Linn., 1766, addenda (*lacertina*).

Reptilia: *Alligator* Cuv., 1807, 25 (*mississipiensis*); *Calamaria* Boie, 1827, 236 (*calamaria*); *Chelydra* Schweigg., 1812, 292 (*serpentina*); *Crotalus* Linn., 1758a, 214 (*horridus*); *Dermochelys* Blainv., 1816, 119 (*coriacea*); *Eremias* Wieg., 1834, 9 (*velox*); *Lacerta* Linn., 1758a, 200 (*agilis*); *Mabuya* Fitz., 1826, 23 (*sloanii*); *Phrynosoma* Wieg., 1828, 367 (*orbiculare*).

Pisces: *Blennius* Linn., 1758a, 256 (*ocellaris*); *Echeneis* Linn., 1758a, 260 (*naucrates*); *Esox* Linn., 1758a, 313 (*lucius*); *Ophidion* Linn., 1758a, 259 (*barbatum*).

C. W. STILES,
Secretary to the International Commission on Zoological Nomenclature.

Hygienic Laboratory, Washington, D.C.

Chemistry and the State.[1]

By Sir ROBERT ROBERTSON, K.B.E., F.R.S.

THE appeal of the State to chemistry has developed through the gradual recognition of the need for the application of that science to matters relating to its preservation, its currency, its financial support, its health, its food supply, its industries, and finally to academic science. In the course of this development in Great Britain, advantage has been taken, if sometimes tardily, of the general advance in chemical knowledge, and frequent recourse has been had to the advice of well-known chemists of the day, and collectively of the Royal Society; thus for various purposes the following chemists, as officials or consultants, have in the past afforded assistance in the solution of specific problems referred to them, or by taking part in Commissions: Boyle, Newton, Davy, Faraday, Daniell, Graham, Hofmann, Redwood, Abel, Roberts-Austen, Percy, Dupré, Playfair, Frankland, Ramsay, and Dewar. It has happened in several instances that as a result of these Commissions and references to chemists, some definite chemical activity of the State has emerged.

The following summary reviews the State's chemical activities before, during, and after the War.

BEFORE THE WAR.

Defence.—For the defence of the State, establishments for the production of explosives were early maintained, and when this ultimately took the form of a chemical manufacture, the Government factory took the lead in devising efficient processes, while from the various State research establishments has issued during the last fifty years an important body of original contributions to the theory of explosives and to the knowledge of their properties.

Metallurgy.—The metallurgical progress of the country has always been a concern of the State by reason of its application to defence by land and sea, and close touch has been maintained with successive developments in the manufacture and use of cast iron, wrought iron, steel, and non-ferrous alloys. While the main advances in process have been made in the great iron and steel works, material contributions to knowledge in this sphere have been made by chemists in the Government service.

Revenue.—For the revenue of the State, imposts were applied in early times, but with great uncertainty, until the charge was put on a scientific basis. Very accurate tables for the strength of alcohol were worked out under the supervision of the Royal Society at the end of the eighteenth century, to be superseded by revised ones issued only a few years ago, when, in addition, new tables were issued also by the Government Laboratory, for determining the gravity of worts before fermentation. The question of rendering alcohol unpotable, but still useful for industrial purposes, has occupied much attention. It was on account of the necessity for safeguarding the revenue that the Government Laboratory was primarily erected, although it now performs chemical work for all State Departments of Great Britain.

Health.—The three main steps with regard to public health and sanitation in this period were the forcing of these questions into prominence by Playfair, with the consequent Commissions and legislation leading to the formation of the Local Government Board and its successor, the Ministry of Health, which has many varied activities in preserving purity of air and water and protecting the workman in dangerous trades; secondly, the determination of standards for a safe water supply by the pioneering work of Frankland; and, thirdly, the appointment of public analysts by the local authorities, with the Government Laboratory as referee, for safeguarding the supply of food.

Agriculture.—Science was being applied to agriculture about the end of the eighteenth century, and at the beginning of the next, Davy did pioneering chemical work for the Board of Agriculture. Private endeavour is responsible for the next development, State action being limited to the prevention of fraud in the sale of fertilisers and feeding-stuffs. In 1909, however, the annual allocation of a sum of money to the Development Commission for the advancement of agriculture stimulated research in a large number of institutions engaged in the scientific study of problems in which chemistry plays an important part.

Other Activities.—In addition to the chemical work referred to above, there is a variety of subjects connected with State Departments to which chemists have contributed, such as the composition of the sea, and the composition and physical chemistry of rocks and building-stone. At the Government Laboratory a large number of investigations have been conducted on matters directly referred from Government Departments.

DURING THE WAR.

In all the activities described, the War requisitioned the work of the chemist, but, naturally, predominantly to meet the demands of active warfare.

Defence.—The attention that had been bestowed on the subject of propellants enabled expansion to take place with no important alteration in the technique of their manufacture, to which was adapted a new type of cordite, ultimately made on the largest scale, without using an imported solvent. For high explosives Great Britain was in much worse case, as these had not been made by Government, and were manufactured only in small quantity. Their study at Woolwich led to a rapid evolution of new processes, substances, and methods of use. Thus a method was worked out for the manufacture of trinitrotoluene, and to save this substance a new high explosive, amatol, was devised. This explosive, consisting of ammonium nitrate and trinitrotoluene, passed exhaustive trials and was ultimately produced at the rate of 4000 tons a week. The production of the ammonium nitrate for the mixture was in itself a stupendous undertaking, and the methods of filling the explosive into shell and other munitions gave rise to much ingenuity. In the Research Department, Woolwich, the number of qualified chemists engaged

[1] From the presidential address to Section B (Chemistry) of the British Association, delivered at Toronto on August 7.

in the study of explosives in all their aspects ultimately exceeded a hundred, while for manufacture and inspection more than a thousand were employed. The ideal set before himself by Lord Moulton in 1914, to produce nothing less than the maximum of explosives of which Great Britain was capable, was realised, and they assumed a quality and character that caused them to be copied by our Allies, and proved themselves more trustworthy than those of the enemy.

Starting unprepared, and without the advantage of a well-developed fine chemical industry, Great Britain was able ultimately to make a reply in the field of chemical warfare that was rapidly becoming more and more effective; at the same time, by study and often self-sacrificing experiment, protecting the soldier by the development of very efficient respirators. In this connexion and in that of explosives, nearly every professor of chemistry in the country, and many from beyond the sea, were engaged.

Metallurgy.—The enormous demand for metals for munitions and countless other war requirements led to an unprecedented concentration of the metallurgical industries on the needs of the State, and to an equal concentration of metallurgical science on investigation devoted to improvement in quality of materials for new and special war purposes. The work of the Aircraft Production Department, aided by many metallurgists and engineers, on alloy steels; of the National Physical Laboratory on aluminium alloys; and of the Metallurgical Branch of the Research Department, Woolwich, on the heat-treatment of heavy forgings and on the drawing of brass, is typical of the successful effort made in every quarter. The knowledge thus gained was disseminated in the form of specifications, instructions, and reports, and has had a great and permanent effect on manufacture.

Health.—A committee of the Royal Society had been studying food values, and was able to afford the Food Controller, when he took office, valuable data bearing on the rationing of food. The committee had dealt with subjects which shortly became of much importance, such as a better recovery of flour in milling wheat. The chemical examination of the food for the Army during the War, carried out by the Government Laboratory, employed a large staff of chemists. For the supply of many fine chemical substitutes used in medicine and surgery, formerly imported from abroad, such provisional arrangements had to be made as the organisation of a large number of university laboratories on a semi-manufacturing basis.

Agriculture.—Effects on agriculture during the War were shortage of the usual feeding-stuffs for cattle and of fertilisers. The chemists stationed at Rothamsted gave special attention to the shortage of manures and prepared instructions for the guidance of farmers; and several sources of supply of potash were exploited, including kelp, felspar, and the flue-dust of furnaces. As sulphuric acid was required for explosive work, fine grinding of phosphates and basic slag was adopted and found to be more efficient than was expected. Shortage also directed the attention of chemists to the use of little known food-stuffs, especially for cattle, and the information gained as to their feeding value was important.

Other Activities.—In many other activities in connexion with the War, chemists were directly involved, such as in affording advice on the conservation of materials, on the numerous questions arising from the operations of the War Trade Department, on the restriction of imports and exports, and on matters of contraband.

AFTER THE WAR.

The magnitude of the chemical effort, it can be claimed, was a factor in winning the War which must be reckoned as of importance only second to that of the bravery of our forces in the field. But it has left a lasting mark, and given to chemistry a value which, were it not for the rapidity with which the achievements of science are forgotten, ought to keep before the public its connexion with almost every phase of activity.

Defence.—To take our subjects in the same order, we may consider some of the effects of the energy spent on the production of munitions. The intensive study of explosives and of other chemical substances used in the War has led to a more complete knowledge of their chemistry, their physical and explosive properties, and has advanced chemical theory. These advantages are not of military importance only, but are reflected also in the production of trade explosives. The collected records of the Department of Explosives Supply afford examples of treatment of many problems of interest to the general chemical technologist, and not only to the explosives expert.

A further benefit was reaped by chemists in every position, from the professor to the youngest graduate, coming into direct contact with manufacturing methods and thus gaining insight into the applications of their science. While it is true that the opportunity came to few of these to take part in the design of plant and primary choice of process, nevertheless the experience was a novel one, as it led them into the field of technology, and cannot fail to have widened their outlook. It became apparent that there was a shortage of a type of chemist which had been developed in Germany, skilled in the transference of the chemical process from the laboratory to the works scale in the largest enterprises. A chemist of this type is one who, besides having a sound knowledge of chemistry and physics, has had experience in the materials of construction used on the large scale, and in the operation of the usual types of plant for carrying out the operations of chemical manufacture, and is capable of working out flow-sheets illustrating the process, and operating plant with every regard to economy. The need for instruction in such subjects had been borne in on men like the late Lord Moulton, and as a direct result of the war-time experience of our deficiencies in this direction has arisen the movement for creating chairs of chemical engineering in some of our universities. It is to be expected that from these schools, especially where the instruction is superimposed upon a full graduate course, will come men who will lead the way in the application of academic science to industry.

Metallurgy.—While the interest of metallurgical science in war material has fortunately fallen to a peace-time level, State participation in the support of scientific research remains far greater than before the

War. In metallurgy it is exercised through the Department of Scientific and Industrial Research, with its organisations of the National Physical Laboratory and the Industrial Research Associations, as, for example, those dealing with the non-ferrous metals and with cast-iron. The State also continues to maintain efficient research departments for the Fighting Services, but it is significant that the largest of these is undertaking industrial metallurgical research on a considerable scale, for the benefit of the brass and other industries. State support and encouragement are undoubtedly powerful factors in the rapid progress now taking place in every branch of metallurgical science in Great Britain, and there is scarcely any related industry which can fail to benefit.

Revenue.—Since the War the principal matters affecting the revenue are the higher duties, which have rendered necessary a further denaturation of alcohol. Improved facilities have been granted for the use of alcohol for scientific purposes and in industry; regulations have been formulated for the use of power alcohol, and duties have been established on imported fine chemicals and synthetic dyestuffs.

Health.—The food shortage during the War directed attention to the nature and quantity of our food supplies, and led to further investigations being undertaken by the Department of Scientific and Industrial Research on food preservation and storage. Activity is also shown by the appointment of committees which are working on the subject of preservatives and colouring matter in food, and on the pollution of rivers by sewage and trade effluents. A great field is open in the co-operation of chemistry with medicine in the discovery of substances suitable for the treatment of the numerous diseases now traced to parasites in the blood.

Agriculture.—So far as fertilisers are concerned, the lack of a supply of fixed nitrogen from the air which obtained throughout the War has now been rectified, and Great Britain for the first time is no longer exceptional among the nations by neglecting to provide itself with synthetic ammonia for agriculture and for munitions. Such war-time expedients as the use of nitre-cake instead of sulphuric acid for making ammonium sulphate and superphosphate, and the recovery of potash from flue-dust, have not survived, but there has been a gain in the further development of "synthetic farmyard manure" and the increased use of basic slag. The present activity in research in agricultural chemistry of a fundamental character is leading to a better understanding of problems of the soil and of plant and animal nutrition, and cannot fail to be of ultimate benefit to farming.

Organised Applied Research and Assisted General Research.—Established during the War as a result of an appreciation of the contrast between the successful application of scientific method to military purposes and the want of such application to many of our manufactures, the Department of Scientific and Industrial Research has extended over a wide field. Its main activities are in the directions of State encouragement to industry to apply chemistry to its problems, of State investigation of vital problems beyond the sphere of private enterprise, and of assistance to workers in the purely academic field. In all these spheres activity is shown by the contributions to knowledge already forthcoming.

PERSONNEL.

In the expansion that has occurred in the chemical sections of State Departments since the War, it is interesting to note the increase in the number of chemists that are employed. So far as can be gathered, the number of chemists working in departments maintained wholly by the State is 375 for the present year, compared with 150 in 1912, while in establishments to which the State affords partial support, such as those under the Development Commission and the Research Associations, the corresponding numbers are 150 and 50. In addition, grants are made to 145 research students and to 11 independent research workers, involving a yearly sum of about 50,000*l.*

DEVELOPMENT OF CHEMISTRY IN THE MODERN STATE.

From the foregoing account of the connexion of the Departments of State in the United Kingdom with chemistry, it is possible to trace a gradual development and ultimately a change in attitude, in passing through the stages of compulsion, expediency, and assistance.

From motives of security the State was compelled to give heed to chemical matters involved in its defence, such as those which appertained to munitions of war, including metals used in their manufacture; it was constrained to uphold the standard of its currency; and it was obliged to secure a revenue. As a consequence, the first chemical departments were set up in connexion with these activities, and from them have emanated notable additions to chemical knowledge, improvements in methods of manufacture, and specifications for Government requirements that have led to improved material becoming available for civilian use. Although mostly conducted with inadequate staff, the study of these questions, it can be claimed, proved of national advantage when the time of need arose.

In the next stage, the public conscience having been awakened by the pioneering work of Playfair, it appeared expedient to safeguard health by attention to sanitation, and, as the quality of food was unsatisfactory, to set up a chemical control. Although a start was made by Davy, a member of the Board of Agriculture of the day, progress in this subject passed to private enterprise, and a century elapsed before direct assistance was afforded to this important matter. Out of these activities come our present system of supervision over the purity of air, water and food, and also the recent progress made in the application of chemistry and physics to problems of the soil.

The last and more recent stage is in the nature of a recognition that the State is under an obligation to assist science, and in this case the science of chemistry, on which so many important industries are based. The War brought home the danger that, although the record of Great Britain as regards discovery in pure science was unrivalled, its systematic application was too often left to other countries, with the result of lamentable shortages during the War and the risk of many industries being ineffective in peace. A measure of government intervention and action appeared

requisite, and research became the business of a government department. Outside of the great firms which maintain progressive chemical staffs, the firms in numerous industries have been encouraged and assisted to co-operate in the betterment of their manufactures by the application of the methods of science, and from these associations and the organisations dealing with national problems begins to flow a stream of communications indicative of useful work accomplished. Nor is the foundation of it all neglected, for encouragement is given to workers in the academic field to follow out their ideas, whithersoever they may lead them, in accordance with the truth that "research in applied science might lead to reforms, but research in pure science leads to revolutions."

It is important to be able to record an advance in securing an interchange of information among government departments, and between their work and that of the universities, a matter which before the War was unsatisfactory, as it was mainly personal and sporadic. It is also a hopeful sign that, although the knowledge and appreciation of the methods and capabilities of science are still generally wanting, there have been signs of late years that these matters are coming to engage the attention of those who guide the policy of the State.

Centenary of the Franklin Institute.

On March 30, 1824, the Governor of the State of Pennsylvania signed an Act incorporating the Franklin Institute for the Promotion of the Mechanic Arts. The centenary of its foundation will be observed in Philadelphia on September 17, 18, and 19, by celebrations reminiscent of the rise, growth, and continuity of purpose of a remarkable institution, now, after many inevitable vicissitudes, rooted deeply in the national life of the United States, at the same time commanding the allegiance of men of science in most other countries. Accordingly, delegates representing several of the universities of Great Britain, as well as scientific societies, will join those from Canada, France, Holland, and Germany in united expression of congratulation. To have wrested "secrets of excellent use" from Nature marks and cements the common bond.

When we direct our minds back to the Institute's initial year, 1824, it serves us to recall that here, in England, we had Sir Humphry Davy—at the height of his fame—installed as president of the Royal Society, whilst round about that period many special scientific organisations were springing into being. Among such were the Horticultural Society (1804), Geological Society (1807), Institution of Civil Engineers (1818), the Royal Geographical Society (1830) and the British Association (1831).

The Franklin Institute was established to meet the need for an institution similar to that founded in London in 1799 (the Royal Institution) by Benjamin Thompson, Count Rumford. The founders had before them, also, the history and objects of the Anderson College of Glasgow, where Dr. George Birkbeck had lectured on mechanics and applied science with inspiring zeal and successful issue. The initial tentative effort was due to two Philadelphians, Samuel V. Merrick and William H. Keating, the latter then chosen by the University of Pennsylvania to occupy a new Chair of Chemistry in its Application to Agriculture and the Mechanic Arts. They discussed a project—one of them, by the way, had been told he was wasting his time—but they were bent upon going forward. They called in two others as colleagues, and the four—all young men—using the Philadelphia Directory, selected from it the names of some 1500 citizens, inviting them by circular letter to attend a meeting on the evening of February 5, 1824, to discover and talk over plans. The meeting was a success, not a little to the surprise of its conveners, approbation of the purpose in view, namely, that of assisting the knowledge of physical science and its diffusion in the arts and sciences, being expressed freely. Later, an election of officers took place, and the promoters chose a name for their offspring. Certainly none could have been more fitting than that of "Franklin Institute," both for immediate testimony and posterity's keeping. There seems to have been no dissension. The glamour of the great "printer-philosopher" was with them in the city where he had worked, and hence homage was rendered. The original scheme prospering, in twelve months' time the corner-stone of a marble-fronted building, destined as a home, was laid (we are told "in ancient and Masonic form by the Grand Lodge of Philadelphia, in the presence of the Society") on June 8, 1825, and completed in 1826. Upon the first floor (to-day) are located the lecture room, laboratories, and offices. The second floor is occupied by the library, whilst the third is devoted to the Museum of Models and Historical Apparatus.

Membership of the Institute is open to men and women, without regard to distinction of race, nationality, or religion, the only requirements for admission being good character and interest in its work. The artisan and the professor meet within its walls upon an equal footing, and it is to this happy blending of "Science with Practice" that the particular usefulness, past and present, of the Institute must be ascribed. General meetings are held once each month, except during the summer. At these, inventions and discoveries, important engineering projects and notable achievements in all fields of scientific progress, are presented, exhibited, or discussed. Many epoch-making inventions have been shown in their experimental stages at these meetings—for example, the phonograph, electric arc, the typewriter, liquid air apparatus, and telegraphy improvement devices. The average membership for the period 1912–1922 was 1380, and in view of the greater interest now manifested in the Institute's work, special efforts are to be made towards an enlargement of its roll.

Three permanent features of the Institute's activities are the maintenance of a reference library, the holding of exhibitions, and the publication of a Journal for the diffusion of knowledge on all subjects connected with science and the useful arts. All three formed part of the original plan of the founders, and the efflux of time has added materially to their importance. We gather from a recent report referring to the library that it is,

of its class, second to none in the United States, embracing the publications of the principal scientific and technical societies of the world. An extensive collection of patent literature has been brought together indispensable to inventors and manufacturers. It is worthy of mention that in 1922 the library received a unique and valuable collection of books and pamphlets on windmills, inclusive of treatises on the subject printed in German and Dutch in the seventeenth and eighteenth centuries, and a book of 400 views of windmills in all parts of the world. As a means of fostering the mechanic arts, the holding of exhibitions was very early encouraged, and for many years kept in view. A notable one was the Electrical Exhibition of 1884, held under the direction of the Institute and by Act of Congress made international in character.

The Journal of the Institute in its present form is an octavo of about 150 pages, published monthly, and it consists in large part of reports of lectures delivered before the Institute and its sections, together with selected original communications from specialists. Mention may be made of a paper by Dr. F. W. Aston, on "Atomic Weights and Isotopes," being a summary of a series of lectures delivered before the Institute in 1922. A series of lectures was also given in 1923 by Sir J. J. Thomson, on "The Electron in Chemistry." Here it is convenient to record that the Institute now publishes annually a "Year Book," which we may say is one of the most concise and distinctive issues of the kind that we have seen.

Various honorary awards of medals and premiums are made by the Institute, some of which are of old standing, and highly valued, such as, for example, the Elliott-Cresson, Potts, and Longstreth medals. The most recent foundation is the Franklin gold medal (with diploma), instituted in 1914, and allotted annually to those workers in physical science or technology, without regard to country, whose efforts, in the view of the Institute, acting through its Committee on Science and the Arts, have done most to advance a knowledge of physical science and its applications. The latest recipient of this gift was Sir Ernest Rutherford.

Under new rules, adapted to modern requirements, the Institute conducts investigations, through its Committee on Science and the Arts, on the soundness and practicability of inventions, discoveries, and improvements in physical processes or devices, submitted to it. During the past twenty-five years nearly 1000 applications have received adjudication.

In 1921 the Institute received a bequest from Henry W. Bartol, a life member, of 1,208,468 dollars for research. Agreeably therewith a "Bartol Research Foundation" was established for the purpose of conducting researches relating to fundamental problems in physical science, particularly those in the field of electricity, and for the investigation of specific problems of a scientific nature which may arise in the industries. An arrangement was made to build a laboratory wherein to engage in these objects, but unfortunately up to the present nothing has reached fulfilment, owing to the high cost of building construction. It is a trust which we may be sure will eventually become operative.

The principal events of the Centenary programme comprise, on the first day, an assembly at the Franklin Institute, and an academic procession to the Walnut Street Theatre, where the Mayor of Philadelphia will deliver an address of welcome, and addresses will be given by Dr. W. C. L. Eglin, president of the Institute, and Prof. Elihu Thomson, honorary chairman of the Centenary Celebration Committee. On September 18 the chief fixture is a lecture on "The Natural and Artificial Disintegration of Elements," by Sir Ernest Rutherford. The morning of September 19 will be taken up by the unveiling of a tablet in connexion with the Bartol Research Foundation. Addresses will afterwards be given by Dr. Arthur D. Little, of Cambridge, Mass., on "The Fifth Estate," and by Prof. Jacobus, advisory engineer, the Babcock and Wilcox Co., New York City, on "Stimulation of Research and Invention." Garden parties, and fraternal hospitality in the shape of banquets to the delegates and guests, have all been provided for in unstinted fashion. A list of speakers at the sectional meetings has been drawn up. These include Sir Charles Parsons, Sir William Bragg, Prof. E. G. Coker, Prof. A. A. Michelson, Prof. Zeeman, and Prof. F. Haber.

NATURE proffers its heartiest congratulations to the Franklin Institute on the occasion of the Centenary, and its earnest hopes for future development and prosperity. T. E. J.

Current Topics and Events.

THE three hundredth anniversary of the publication of Francis Bacon's famous "De Dignitate et Augmentis Scientiarum" was fittingly celebrated at the seventy-eighth meeting of the American Association for the Advancement of Science at Cincinnati by a symposium of five papers, which have recently appeared in *Science*. Special interest attaches to the first of these by Prof. Mark H. Liddell, of Purdue University, outlining Bacon's scheme for a College of Research. His plea for the proper organisation of research is preceded by an attack on the neglect of science in the university of his day. "If any man thinks pure science an idle pursuit he fails to realise that from thence is all applied science supplied." Bacon accuses the college professor of his day of lacking in virility, and attributes this in part to the smallness and meanness of his emoluments. He also accuses the universities of their failure to produce facilities for research "in the way of laboratories, botanical gardens and other instrumentalities of investigation," and insists that "research is the intelligence department of organised knowledge," and hence must be properly financed. So Bacon comes to his own programme for the regeneration of learning by research, along two broad lines: one to provide the scientific method for the *magna instauratio*, the other the material and personnel to make it effective. The former of these he achieved in 1620 with the publication of the "Novum Organum." The second object, the provision of the College of Research (Bacon called it a College of Inventors), was never realised, but his own memorandum,

originally drafted in 1608, clearly outlines his intentions. Bacon contemplated a building equipped with libraries, laboratories, furnaces, vaults, and workshops, together with a hall of fame for statues of the great men of science, past, present, and future. There were to be rules for the conduct of studies and research, and money allowances for travelling expenses and for apparatus. There was also included a scheme for the recording of results in cipher until the time for publication was deemed appropriate. Finally, the scheme provided not only for the due rewarding of valuable research, but also for the removal of members whose work was fruitless.

ORNITHOLOGISTS have recently been hearing a good deal of the International Museum of Comparative Oology at Santa Barbara, California. We have now before us the first number of the Journal of this Museum, edited by the director, W. L. Dawson, and entitled *The Comparative Oologist.* Throughout, the claim is made that oology is an independent science of considerable importance—once indeed we are told that "Oology is the science of one half of the biologic process"; but the Journal itself enables us to see how much weight is to be attached to these claims. We will content ourselves with one passage, in which the editor informs us that the shell of a bird's egg has been formed in the ovary, "that innermost sanctuary of life"! and therefore enables us (how is not stated) to penetrate into the mysteries of "the reproductive stream itself." Numerous other quotations could be made to show that Mr. Dawson, while admirably qualified to write of generalities in a high-faluting style, appears to be unfamiliar with elementary facts concerning his special subject-matter. We wonder what men like Dr. R. Ridgway, Dr. Shufeldt, Mr. Oberholsen, or the Rev. F. Jourdain will feel when they see themselves associated with the highly original avian anatomy and physiology of the sort we have quoted. We may also quote from the rules: "Any person of scientific integrity, having attained the age of 18, who is interested in the pursuit of oology as a science *or in the collecting of birds' eggs* (italics ours) may become a 'Scientific Member' of the Museum." That is what many had supposed: now we know it. But the Museum cannot have it both ways. It can be a centre for egg-collectors, patrons of what is an amusing and interesting sport if not carried (as unfortunately sometimes happens) to the pitch of mania. Or it can be an institution for the scientific study of egg-shells, from which we may doubtless expect some, though not very much or very valuable, new knowledge. But it must not think that it can use science as a cloak for mere collecting; and that is precisely what, with its present rules and organisation, it appears to be trying to do.

THE subject of chemical apparatus and plant production generally received special consideration in the recent address of the retiring chairman (Mr. L. M. G. Fraser) of the Chemical Plant Manufacturers' Association. The improvements in the construction of plant have been along well-defined lines, the aim being to produce a better article at a lower working cost and with greater safety. Examples were given indicating lines of progress, and reference was made to (1) the more economic output of grinding machines, (2) the simplification of emulsion formation, (3) the increased usefulness of filter plant and the development of the stream line filter, (4) the distillation of special liquids with less risk and greater economy and the more efficient fractionation in still columns, (5) improved mechanical crystallisers and mixers, (6) the more thorough understanding of furnaces, and (7) the control of temperature. The better utilisation of metals and alloys and the more intimate knowledge of the action of heat on substance are regarded as factors which have helped progress. The separation of ashes from coke and unburnt coal by means of electromagnetic separators is now being carried out on a commercial scale. Recent developments in electrolytic cells were also noted, and the need for further investigation on the electrolysis of certain inorganic substances indicated. Mr. Fraser is hopeful that, with experience from similar work in other directions, plant could be properly designed to meet new needs. Many general questions bearing on plant construction were touched upon, such as the power factor in the movement of bulk materials, the study of the thermal efficiency of fuels and the interchange of heat, the general freedom from breakdown of machinery and the automatic control of operation. Improvements so far achieved have enabled many difficulties to be overcome, and future plans can be laid with greater confidence.

Two series of coloured postcards have recently been issued by the British Museum (Natural History), one depicting the migrant bird visitors of spring, the other those of winter. A separate card is devoted to each species, and in many instances, to an excellent "close-up" view of the bird in its normal surroundings, there is added a more distant view which indicates with great success the features that catch the eye "in the field." The colouring is very faithful to life, and the artistic effect of each card delightful. Each series is offered in sets of five cards for 1*s*., the cards being numbered in the order in which the birds usually arrive in Great Britain. Thus the first set in the spring series contains wheatear, ring-ouzel, chiffchaff, sand martin, and swallow; and that in the winter series, snow-bunting, redwing, brambling, fieldfare, and hooded crow. Accompanying each set is a printed leaflet in which the breeding and migration habits of each species are set out. In addition to giving much pleasure to all bird-lovers, these cards should prove of great value to teachers in supplementing lessons in Nature study, especially in urban schools and in those which have not the good fortune to possess a natural history museum.

THE number of new periodicals dealing with various aspects of natural science which have been started in Japan in the last few years, is clear evidence of the attention now being given in that country to the investigation of its own natural resources; for most of the journals contain papers dealing with products occurring in Japan or which are being imported into

Japan for use. One of the most interesting of these journals is *Acta phyto-chimica*, now in its second year, which is published by the Iwata Institute of Plant Biochemistry at Tokyo, and edited by Prof. Shibata. In it have been published already a number of important papers, including those of Asahina and Fujita on anemonin, and a detailed résumé by Asahina on his work on *Evodia rutæcarpa*, which has resulted in the isolation of two new alkaloids, evodiamine and rutæcarpine. The structures of these bases have been determined, and shown to be related to those of harmine and harmaline, familiar to British chemists through the work of Perkin and Robinson. No less interesting is the series of papers by Shibata and his collaborators on natural flavone colouring matters. In the current number of the journal (volume ii. No. 1), Prof. Asahina and several of his students have an important paper on the ketone of the essential oil of *Elsholtzia cristata*, Willd., which is shown to be a furan derivative, and is only the second substance of this type thus far found among the thousands of known components of essential oils, the other being Semmler's carlina oxide.

A REPORT of the administration of the Meteorological Department of the Government of India in 1923–24, by Sir Gilbert T. Walker, Director-General of Observatories, now retired, has recently been issued. Reference is made to retrenchment of expenditure and to its interference with effective weather warning. The main curtailment of expenditure was effected in telegraphic charges. The issue of the Calcutta, Bombay, and Madras reports was restricted to periods of 10½, 6, and 9 months respectively, and the number of stations reporting was greatly curtailed. Four cyclonic storms were formed in the Bay and one in the Arabian Sea. In May, a severe cyclone was experienced in the Bay, in which the S.S. *Okara* was lost. The loss of this vessel has led to certain changes in the method of broadcasting important weather information, more frequent weather warnings being issued. In connexion with the upper air work, which centres round the Agra Observatory, out of 36 "instrument balloons" sent off during the year, there were 21 recovered. Pilot balloon work was started at Bombay and Peshawar. An extension of meteorograph flights is contemplated so as to obtain observations to heights of 12 miles or more, and to participate in the important work undertaken in other countries. Radio weather messages are received from ships and greatly supplement the coast observations in the warning of cyclones. For the "Rainfall of India," observations are received from nearly 4000 stations. Seismological observations are recorded at several places in India and are forwarded to the Seismological Committee of the British Association.

THE *Marine Observer* for September, published by the Meteorological Office of the Air Ministry, has recently been received. It is prepared under the supervision of Captain L. A. Brooke Smith, the Marine Superintendent. The publication is essentially a vehicle for supplying to seamen valuable meteorological data of interest for voyages in all navigable seas; numerous incidents are given from the meteorological logs kept for the Office, and mariners are invited to contribute information of interest if not regular observers. The current number contains an article on "The Origin of Tropical Revolving Storms" by Capt. D. Brunt, Superintendent of the Army Meteorological Services. A large amount of wireless weather information is given, a special chapter in the issue for each month dealing with a different branch of meteorological information; the September number deals with "wind and set and drift of current." Specimen charts show currents and winds experienced in home waters, cyclone tracks are given for various oceans, a map shows recent ice in the North Atlantic, and notices are given of recent derelicts and floating wreckage. The August number contained a discussion on the "Hong Kong Typhoon, Aug. 18, 1923," by Commander J. Hennessy, the Nautical Senior Professional Assistant; also an article on fog by Mr. H. Keeton. A list of contents would be a useful addition to future issues.

THE first conference of Special Libraries and Information Bureaux was held on September 5-8 at High Leigh, Hoddesdon, Herts. The objects of the conference were outlined at the opening session by Dr. R. S. Hutton, director of the Non-Ferrous Metals Research Association, and Mr. J. G. Pearce, director of the Cast Iron Research Association. It has long been felt that many diverse agencies concerned with the treatment of information have problems in common, and need an opportunity to establish mutual co-operation and assistance, and to determine their relationship to the press, and to the great municipal and national libraries and other institutions. The conference, which was highly successful, provided abundant evidence of the interest in this field of work, and in order to ensure continuity of interest, without forming another association, a standing committee of the conference was appointed with power to consider matters in the interests of those engaged in directing or operating Special Libraries, and to convene a further conference at some future date. This committee is representative of a wide range of institutions, and has already held its first meeting. The most striking feature of the conference was the keenness displayed by a large number of highly diversified interests, including scientific, technical, industrial, wholesale and retail commerce, railways, political, agricultural, governmental, universities, press, medical, sociological and banking. This diversity served to emphasise the common interest of all these agencies in receiving, treating and distributing documentary material.

THE thirty-fifth annual general meeting of the Institution of Mining Engineers will be held at the Conference Halls of the British Empire Exhibition on Thursday and Friday, October 2 and 3. Sir John Cadman will relinquish his third term of office as president on October 2, when he will be succeeded by Dr. J. S. Haldane, Director of the Mining Research Laboratory and honorary professor in the University of Birmingham.

M. MENGÈS, whose recent book was noticed briefly in NATURE of July 19, p. 85, writes to suggest that we misinterpreted him. In reply we would explain that the phrase " proposes in some measure to revert to the older 'classical' conceptions " was not intended to throw any doubt on the novelty of his ideas It was only intended to indicate that his theory approximates more nearly to classical than to relativity theories.

AT the opening session of the annual autumn meeting of the Institute of Metals, held at the Institution of Mechanical Engineers, London, on Tuesday, September 9, Prof. T. Turner referred in his presidential address to the growing needs of the Institute in view of the steadily increasing membership, the growth of the library, and the greater use by members of the facilities which are provided. Additional funds are required if the work is to be maintained and extended; and the alternative to a further increase in the annual subscription is an endowment, the proceeds of which would be available for providing the necessary additional accommodation and assistance. Prof. Turner was able to announce a gift of 1000*l.* towards such an endowment. This donation is the largest single gift which the Institute has received, and the Council will shortly take into consideration the question as to how far, and in what manner, it may be made the basis of a larger scheme.

Two junior assistants are required by the Research Department, Woolwich, for analytical work in connexion with Internal Ballistics problems. Candidates must possess first-class honours in mathematics. Written applications, with copies of testimonials, must be sent to the Chief Superintendent, Research Department, Woolwich, S.E.

WE have received from Messrs. Boots their list of special research chemicals. We note that the number of these has increased considerably, and that a great majority of the compounds are manufactured or purified in Messrs. Boots' own laboratories in Nottingham. As manufacturers and distributors of fine chemicals, Messrs. Boots are in a position to supply, in a state of considerable purity, many of the intermediates and raw materials which are of interest to workers engaged in chemical research.

Two useful catalogues of second-hand books offered for sale by Messrs. Bowes and Bowes, Trinity Street, Cambridge, have reached us. One (No. 422) is of a miscellaneous character dealing with works of biography, sport, travel, English topography, general literature, and of foreign origin. The other catalogue (No. 423) contains particulars of nearly 3000 works relating to mathematics, pure and applied; including physics, astronomy, meteorology, electricity, engineering, assurance, insurance, etc. The catalogues are obtainable from the publishers upon request.

Our Astronomical Column.

STATISTICS ON STELLAR VELOCITIES.—One of the chief factors in the rapid progress made in recent years regarding stellar distribution and motion has been the substitution of accurate statistical methods for the haphazard investigations of earlier times, which were often based on incomplete material. The *Astroph. Journ.*, June 1924, contains two important statistical papers by Prof. F. H. Seares.

The first deals with stellar velocities, and demonstrates the soundness of Schwarzschild's assumption that the logarithms of the tangential velocities (*i.e.* the velocities deduced from observed proper motion, after correcting for the sun's velocity), for any assigned absolute magnitude, conform very closely to the Gaussian error-curve, sometimes designated " the cocked hat." A similar conclusion is reached for the radial velocities.

The second paper seeks to find a formula for the relative numbers of stars of different absolute magnitudes. The well-known difficulty is present that the extreme dwarfs are invisible unless their distance is small, so that it is impossible to test any region except that adjacent to the sun.

Kapteyn and van Rhijn deduced the mean parallax formula $\log \bar{\pi} = -0{\cdot}690 - 0{\cdot}0713m + 0{\cdot}645 \log \mu$, m being apparent magnitude and μ proper motion. This is shown to agree well with observation for stars for which M is brighter than 8 mag.; but the number of absolutely faint stars is far greater than that indicated by the formula.

The paper emphasises the urgent need of obtaining more parallaxes of these faint stars.

THE THERMOPILE USED FOR MEASURING STAR MAGNITUDES.—Allusion has already been made in this column to the use of the thermopile for measuring the total absorption by a star-image of a beam of light passed through a photographic plate. The method has the advantages of being free from personality and of giving the integrated effect of the whole image independently of the distribution of density in different parts of it. It is thus available in reflector plates to a considerable distance from the centre of the plates in spite of the winged character of the images. Groningen Kapteyn Lab. Publ., No. 32, contains an investigation by J. Schilt which confirms the accuracy and convenience of the method. It has been applied to several of the Cape Phot. Durchm. plates with good results, also to some plates taken with the 60-inch reflector at Mount Wilson.

Stars of determined magnitudes are used for calibrating the curves derived from the thermopile readings; these are taken from the investigations of Seares (Mount Wilson), Chapman and Melotte (Greenwich), and Dziewulsky (Potsdam). It is suggested that the method may usefully be applied to the magnitudes of stars in the Durchmusterung of selected areas.

SOLAR APEX AND VELOCITY.—*Astr. Nach.* 5312 contains a paper by B. Fessenkoff and C. Ogrodnikoff on the solar apex and velocity as deduced from the radial velocities of stars of type B. This method of deducing the apex is a useful check on the method from proper motions. The latter is very sensitive to the effect of systematic errors in the older catalogues, as Kapteyn pointed out. The B stars were selected as being of high mass and small peculiar motions.

Four solutions are given, according to the assumed K effect or the shift of spectral lines arising independently of radial motion. They do not differ very largely *inter se*; in that adopted as most probable, K is taken as corresponding to an apparent recession of 3·15 km./sec. According to this, the sun is moving towards R.A. 265·8°, N. Decl. 31·9° at a speed of 21·7 km./sec.

Research Items.

ROUND BARROWS AND THE STUPA.—In the *Ceylon Journal of Science* (vol. i., part 1, section G.) Mr. A. M. Hocart argues for a connexion between the round barrows of prehistoric Europe and the stupa or tope of Indian and Cingalese Buddhism, adapting a theory of Fergusson's in the light of more recent knowledge. Senart, in opposing Fergusson's view, derived the stupa from the fire temple, connecting it with the solar origin to which he assigned much in Buddhism. There is, however, evidence that the stupa is essentially connected with relics, like the altar of the Roman Catholic Church, and, according to tradition, was erected over the ashes of an emperor and his family. The name *caitya* given to a tope indicates its connexion with the funeral pile, and the bo-tree invariably associated with the tope in Ceylon, to which the term *caitya* is also applied, is probably a tree planted to mark the spot of cremation. The original object of the round barrow and the stupa, therefore, appears to be identical, the fact that brick is employed in one case and earth in the other being immaterial. Further, it is possible that there may be some connexion between the round barrow and the sacred mounds of Fiji, the link being the Basarh mounds, which appear to relate to the latter through a legend of the origin of earthen mounds which, with certain modifications, is common to both.

PREHISTORIC REPRESENTATIONS OF THE HUMAN FORM FROM MALTA AND GOZO.—Dr. Zammit and Dr. Singer have contributed to the Journal of the Royal Anthropological Institute (vol. liv. pt. 1) a comprehensive study—the first to appear—of the interesting statuettes of neolithic age discovered from time to time in the megalithic structures of Malta and Gozo. The statuettes are, with three exceptions, made from local material, the majority being either of globigerina limestone or clay. In the greater number the most prominent characteristic is their obesity, sometimes, but erroneously, called steatopygia. They are classified into four groups—idealised representations, male and female, portrait models, representations of priests or temple officials, and votive offerings. The first group is that in which the obesity is most marked. The buttocks, thighs, legs, arms, and chest are enormously fat; but the head, when present, and the neck are free from fat, while the hands and feet are in all cases small. Taken in conjunction with other characters, these features suggest that a well-known pathological condition has been taken as a standard and has developed into a ritualistic convention. The figures are comparable with representations of the human form in palæolithic art, and similar figures have been described from Crete, the Cyclades, the Morea, Thessaly, Servia, Egypt, Erythrea, and elsewhere. Certain characteristics, however, separate them from all these except perhaps in the case of Thessaly. It is suggested that they may be a specialised local form, coarse and crude, of an art well known from Crete.

THE MAPPING OF OCCUPATIONAL GROUPINGS.—In a series of Norwegian studies published in the *Sociological Review* for July, Mr. A. Farquharson has made some interesting attempts to map occupational groupings in connexion with a discussion of Aandlesness and its occupations. The principle adopted in the experimental coloured map of about $\frac{1}{8}$ sq. mile of the Aandlesness promontory is based on an eight-fold division of simple occupations. These are miner, woodman, hunter, shepherd, upland farmer, lowland farmer, market gardener, and fisherman. For each of these a different colour symbol is used. The derived occupations are indicated by numbers printed over the colour symbols. Thus the derived occupations from mining include smith, tinsmith, stonemason, etc., while, as regards fishing, distinctions are drawn between sea-fishing, fish-curing, and the selling of fish. This classification has the advantage of being evolutionary and indicates the link between simple and more developed occupations, but there are of course cases in which the links are not clear, and could be traced only by research in the particular case and place. In putting forward this tentative scheme, Mr. Farquharson emphasises the need of distinguishing between craft occupations, using the term in a general sense to indicate the making and growing of things; clerical employment; and intermediate occupations such as transport and distribution. The difficulties of this sociological mapping are great, but this attempt is most suggestive of the results obtainable.

VOLCANIC ISLANDS IN THE CHINA SEA.—Two new volcanic islands were reported as having appeared in the China Sea in the eruption of 1923 in approximately lat. 10° 9′ N., long. 109° E. The *Geographical Journal* for August contains a note regarding this occurrence, based on information supplied by the Admiralty. In March this year, H.M.S. *Iroquois* found that both islands had disappeared, and that their sites were covered by water of a depth of about 50 fathoms. The examination also failed to reveal any trace of the 12-fathom bank in the vicinity which had been reported at the same time as the islands. Both the islands and the shallow bank have been omitted from the charts of the China Sea, but caution is advised when navigating in the neighbourhood.

LOAD LINE (ZONES) COMMITTEE.—The report has recently been published of a Committee appointed by the Board of Trade to consider the weather conditions obtaining on the various sea routes of the world, and to advise, having regard to those conditions, to what geographical zones, and what seasons of the year, the application of the special seasonal conditions of loading prescribed by the British Tables of Freeboard may properly be extended. The procedure adopted by the Committee was in the first place to determine the geographical areas in which similar weather conditions exist, and then to study these areas in detail in order to decide what loading restrictions would be necessary. The final recommendations of the Committee are very clearly indicated in a chart of the world printed as an Appendix to the Report. In this chart are shown (*a*) the regions in which winter freeboard should obtain for the whole or part of the year, (*b*) the regions where summer freeboard should obtain for the whole year, (*c*) the regions where weather conditions are more stable than ordinary summer conditions, and in which the deeper "Indian Summer" loading should be permitted, and (*d*) the areas which are specially liable to hurricanes, with a statement in each case of the hurricane season. With regard to the hurricane areas, the Committee did not feel justified in recommending that any new restrictions should be imposed on account of hurricanes, as the number of casualties due to hurricanes, though not accurately known, is small; and in the seasons when hurricanes occur the weather conditions are otherwise favourable. The Committee strongly recommended the issue of a warning to owners and masters of ships which pass through the areas where hurricanes occur that special caution should be observed within those areas, use being made of the rapidly improving facilities for broadcasting weather warnings by wireless telegraphy.

LEFT-HANDEDNESS, STAMMER, AND SQUINT.—The modern tendency to seek for psychological causes for all ailments, whether physical or mental, finds notable expression in a recent article in the *Lancet*, where Dr. W. S. Inman, an ophthalmic surgeon, discusses the origin of squint, left-handedness, and stammer. The connexion between left-handedness and stammering has been observed before, and various attempts have been made to explain it; but always on physiological grounds. Dr. Inman's special contribution to the subject is twofold. While not denying that the causal relation is in many instances to be found in the nervous system, he abandons that line of inquiry and devotes his attention to the discovery of mental causes; and he brings in squinting as a third member of a related group. What he says, in effect, is that left-handedness, stammering, and squinting are but different ways in which the organism responds to emotional stress. The too severe exercise of parental authority in the home, for example, may give rise to left-handedness in one member of the family, to stammering in another, and to squinting in another; or two or three of these peculiarities may appear in any one member. A congenital tendency is, of course, presupposed, for it is well known that each of these defects runs in families. The important point, however, is that the family which is predisposed to any one of these defects is also predisposed to the other two: which of them will actually appear depends upon the general disposition of the person concerned. Dr. Inman thus contends that a self-reliant lad with a strain of perverseness or contrariness in his nature will become left-handed as an unconscious revolt against authority. It is the lad's way of showing that he is "agin the government." Gentler natures are prone to respond to the pressure of authority, or the stress of fear, by squinting. Dr. Inman has opened out an interesting line of inquiry which may lead to important results. The cases he cites form strong presumptive evidence of the general soundness of his views.

ANIMAL PARASITOLOGY. — In a recent address (*Science*, vol. 49, pp. 306-310, 1924) on present lines of attack on animal parasitology, Prof. H. B. Ward referred to the recent rapid development of this subject, which has grown more in the last decade than in the whole previous period of recorded science. He pointed out that methods for limiting the attacks of parasites upon their hosts have outrun, in many cases, the information concerning the structure, development and bionomics of the causal organisms, and also of their transmitting agents, if any, and that therefore additional information concerning the parasites is the first necessity for further progress. He emphasised the need for the careful study of the morphology and differential characters of parasites and for examining the original specimens of a species or of material collected in the same locality and from the same host species. He remarked that problems of epidemiology are fundamentally dependent for their solution upon the correct determination of the life-cycles of the parasites concerned, and referred to the confusions which have occurred through faulty determinations. He rightly directed attention to the success of intensive studies on the parasites of lower animals, where continued observation and experimental and close control of conditions, essential for the thorough testing of the results, are possible, and he strongly advocated the closer co-operation of parasitologists and of specialists in the field of medicine.

MINERALS OF THE PRE-CAMBRIAN IN CANADA.—Dr. C. V. Corless recently read a paper before the Royal Society of Arts on the mineral wealth of the Pre-Cambrian in Canada, which is printed in the Society's Journal of August 15. He showed that the Pre-Cambrian rocks occupy an area of some 2 million square miles, and that only a very small portion of this area, little more than the southern fringe, has been prospected. He pointed out that the Pre-Cambrian rocks in the United States contain the Lake Superior iron mines, which produce the great bulk of the iron ores forming the basis of the vast iron and steel industry of the United States, and the Michigan copper mines, which have long ranked among the important producers of that metal, whereas the same rocks in Canada contain the Sudbury nickel-copper mines, the Cobalt area silver mines, and the Porcupine area gold mines, and that gold has been found widely distributed throughout a great proportion of the Pre-Cambrian hitherto investigated. So far as geological investigations have gone, the general character of the Pre-Cambrian rocks is, broadly speaking, uniform, and Dr. Corless infers "that similar mineralisation would broadly follow similar geological conditions because of the wide geological uniformity proven to exist"; he therefore asks the question: "Is it not a reasonable certainty that the achievements of the past both in discovery and in recovery of minerals in but a few per cent. of the total area will be repeated over and over again in the great Pre-Cambrian area as a whole?" He concluded by stating that he for his part has become fully convinced that the inference regarding the vast mineral wealth of the Pre-Cambrian will be found to be true, and that intensive prospecting within this area promises to yield results of great value.

WAVE-POWER TRANSMISSION.—The Constantinesco system of wave-power transmission has been applied successfully to the synchronisation of the firing of machine-gun bullets from an aeroplane and to the Dorman Long boring machine. In his book "Sonics" the inventor investigates this system, taking leakage and friction into account, and obtains a series of equations which show remarkable similarity to those found in the investigation of long-distance telephone-lines. In the *Philosophical Magazine* for July, Lieut. E. A. Barclay-Smith attempts to expound the phenomena occurring in wave-power transmission and to formulate an easy method of investigating them from first principles. He also gives an indication of the line of investigation to be followed when the data are such as will be met with in practice. The essential feature of this system of power transmission is the production of waves in fluid contained in a pipe by means of a reciprocating plunger at one end; at the other end of the pipe is a motor plunger which is reciprocated by the pressure waves in the liquid. The pipe may have several branches leading to different plungers so that power may be received by several machines. The author first investigates a single pipe full of fluid when a plunger starts to reciprocate at one end and neglects friction and leakage, and he shows that there is created a series of pressure-waves, each accompanied by its corresponding particle-velocity wave and travelling to and fro along the pipe, and he explains how the conditions at any point may be ascertained if those existing at some other point are known. Inertias and hydraulic capacities are then considered, the latter being of two different kinds. Then follows an investigation of the simplest practical case, namely, a generator and motor at either end of a uniform pipe. Three cases are examined: (*a*) The motor piston is fixed; (*b*) the motor piston is oscillating but absorbing no power; (*c*) the motor is absorbing power. The contents of the paper are valuable, but will require considerable amplification before they can be of service to the practical designer.

Germination of Seeds exposed to Low Temperatures.

By H. F. ROBERTS, University of Manitoba.

THIS investigation was undertaken in December 1921. Seeds of thirty species were placed in tin containers (druggists' ointment tins), one lot being left indoors in the laboratory, at a temperature of 75° F., the other lot being exposed out of doors, for 83 days, from January 9 to April 2. In both cases the seeds were kept perfectly dry. After the conclusion of the period indicated, the seeds of both lots were germinated between blotters for 10 days in the laboratory, at a temperature of 72°-75° F. One hundred seeds were tested from each lot, the germinated seeds being counted on the fifth, seventh, and tenth days. Fifteen varieties of garden seeds, belonging to seven species, gave a germination percentage at the end of 10 days of 67 per cent. to 63 per cent. in favour of the indoor lots. For eleven varieties, belonging to eight species, the germination percentage at the end of 10 days was as 70 per cent. to 66 per cent., also in favour of the indoor lots. The twenty-six varieties gave an average percentage germination at the end of 5, 7, and 10 days of 42 : 36, 62 : 58, and 69 : 65 respectively, for the indoor and the outdoor lots, or a preponderant percentage superiority of 6 per cent., 4 per cent., and 4 per cent. respectively, for the three successive periods, in favour of the lots kept indoors.

From the above summary, it appears that a small average increased germination percentage occurred in the case of seeds kept at laboratory temperature. It was noticed that the seeds of cool temperate species developed a germination percentage higher by 25 per cent. (54 : 20) than those of the warm temperate species kept at laboratory temperature, during the first 5 days of the germination period, although the increased percentage was but 14 per cent. (43 : 29) in favour of the same group exposed to the outside winter temperature. The total germination percentage, however, was approximately the same in both cases.

The mean temperature out of doors for the period of the experiment was as follows, in degrees Fahrenheit: Jan. +3·0, Feb. +0·4, Mar. +24·7, Apr. +41·5, May +60·0.

In the winter of 1923, another lot, consisting of fourteen species, in thirty-three varieties, all of them cool temperate vegetable and field seeds, were exposed as before on January 26. On May 12 the different lots of seeds were tested for percentage of germination. In the preceding year's experiment the germination test was made in the laboratory for plant physiology of the University of Manitoba. In the second year the germination tests were conducted in the official Dominion Seed Laboratory at Winnipeg. The results obtained were as follows: As the average of the summary shows, there was a difference of 4 per cent. in favour of the seeds kept at laboratory temperature,—about 2 per cent. less than the average at the end of 10 days for the twenty-six species and varieties tested the preceding year. At all events, the results, although not conclusive, at least point to a slight diminution in total vitality, as the result of continued exposure to low winter temperatures at the latitude of Manitoba. It should be stated that all the seeds tested were in a thoroughly air-dry condition before the beginning of the test.

Sixty-six varieties, belonging to fifteen species, were tested, including carrot, Swedish turnip, mangel, sugar beet, barley, flax, crimson and white clover, cucumber, cauliflower, celery, egg plant, and cabbage. The total averages for all varieties tested were as follows:

	4-day test	10-day test.
Inside . . .	56	73
Outside . . .	57	75

There is therefore seen to be practically no difference in the results as between the seeds kept indoors and those kept outside. If some of the individual cases are examined separately, three varieties of carrots gave at the final test 69 per cent. and 68 per cent. respectively for the seeds outside and inside; six varieties of Swedish turnip, 75 per cent. and 75 per cent.; three varieties of mangels, 56 per cent. and 62 per cent.; three varieties of turnip, 71 per cent. and 73 per cent.; three varieties of cucumber, 79 per cent. and 81 per cent.; four varieties of cabbage, 98 per cent. and 77 per cent.

It thus appears, when the details can be taken in numbers sufficient to indicate an average result, that the data agree with the general average. Inasmuch as the data herein are at variance with the general experience of practical men, horticulturists, etc., with regard to the practical utility of chilling seeds, it is concluded that the general factor of moisture is the effective one, and that the layering of seeds in a moist substratum accounts for the effectiveness of the practice, rather than the temperature factor alone.

Barogram Analysis in Weather Forecasting.

THE Italian meteorologist, Francesco Vercelli, has made a laborious study of barographic records from various parts of the world, and various periods and seasons, submitting these curves to a process of periodigram analysis on the lines familiar in tidal investigations, or as applied to the study of seiches in lakes by the late Prof. Chrystal. The results are described in full detail in a booklet published last year in Rome, under the auspices of the Geophysical Institute of Trieste, entitled "Nuovi esperimenti di previsioni meteorologiche."

From the generalised point of view, the barometric curves are shown to contain the well-known diurnal period which is so outstanding in the tropics, various periods ranging between a few days and a month, and an annual period, together with a small "insoluble residue," representing what must be regarded as irregular fluctuations. The amplitudes of these several periods, and other characteristics thereof, differ greatly according to latitude, season, and continentality. If the periodal composition of a given barogram is known, it becomes possible to synthesise its prolongation on the assumption that none of the contained periods die out or others reappear, and thus to make a forecast of the course of barometric pressure for a longer period than is possible by the ordinary synoptic chart method.

Vercelli claims—and the responsibility for the statement must rest with him—to have obtained remarkably good agreement between the predicted and actual continuations of his curves, and to have used this method of weather forecasting with much success in circumstances of grave responsibility on the Italian Front during the War. He indicates the main source of error to be the liability to cessation, or temporary suspension, of any of the component periods, or the reappearance of others. He also points out that the paper in question, discussing the analysis of

single curves, is only the commencement of the subject, since the next step will consist in co-ordinating the analyses of curves from several places; this would greatly enhance the usefulness of this method of forecasting.

The author does not, however, appear to lay enough stress on the fact that forecasting pressure is by no means equivalent to forecasting weather, and that the correlation between rainfall and the height of the barometer at a place, or even the connexion between rainfall and pressure distribution over an area, is none too close from a forecaster's point of view. One has also to consider the tendency of the weather to get into dry or wet "grooves"; for it is well known that during pronouncedly wet spells, downpours occur in passing barometric configurations that would scarcely yield a drop during a dry spell. Moreover, it does not follow that Vercelli's method, even if found practicable in Italy, would answer in England, where it is possible that the relationship between pressure and weather may be rather more complex. It is just such climatic peculiarities we want to discover, and it is not too much to say that even if a universal application of Vercelli's system to weather forecasting proved wholly unserviceable, which is scarcely likely, it could not fail to bring to light any such interesting climatological differences between one region and another. L. C. W. BONACINA.

Wind, Wave, and Swell on the North Atlantic Ocean.[1]

DURING a voyage from Southampton to Trinidad and back by R.M.S. *Oruba* the period of the waves was taken several times daily, and from this their speed was calculated. The speed of the wind was ascertained by means of a Robinson anemometer (lent by the Meteorological Office), due allowance being made for the speed of the ship and the direction of the wind.

The water is very deep from a short distance beyond Ushant, and free from strong currents so far as Barbados. The speed of the wind ranged from 13·9 to 23·6 statute miles per hour. That of the waves was in all cases less, the difference ranging from 1·0 mile an hour to a little more than 8·0 miles an hour. The latter is sufficient to keep a light flag flying. Anything less than 1 mile an hour is reckoned a calm. The difference was not proportional to the speed of the wind; nevertheless a relationship emerges when account is taken of the observations which were made simultaneously of the swell of the sea. When swell and wave ran precisely in the same direction (as sometimes occurred in the region of the Trade winds) and on one day when no swell was recorded, the speed of the wave was so nearly equal to that of the wind that the breeze blowing over the ridges was only equal to the "light air" which barely suffices to give steerage way to a fishing smack. Such a light air would be detected on land by drift of smoke but would not move a wind-vane. Thus there was no longer a battle between wind and wave.

When the swell followed but crossed the wave the difference in speed of wind and wave was greater, and this difference increased rapidly when the crossing swelling swell was meeting, instead of following, the wave. When the waves were much slower than the wind their height was always small, and sometimes their fronts were short and irregular. It was evident that the growth of waves in both length and height was much hindered by a crossing swell, and it can be safely inferred that the general absence of swell is a sufficient reason for the rapid rise of waves upon enclosed seas. When a wind comes on to blow in the direction of the ocean swell with a speed greater than that of the swell, the growth of large, steep waves is very rapid (doubtless even more rapid than their growth from smooth water), but this occurrence is relatively rare in the North Atlantic.

The direction of the breaker out at sea was found to be intermediate between that of wave and swell (the breaker being formed when they override), so that the practice of observing the direction of "the curl on the water" as a method of determining the direction of the wind gives an erroneous result whenever there is a crossing swell, which is the usual condition upon the oceans The general run of the waves, on the contrary, gives a trustworthy indication of the direction of the wind.

[1] Substance of a paper by Dr. Vaughan Cornish read before Section E (Geography) of the British Association at Toronto on August 8.

Mountain Structure.

THE origin of mountains continues one of the most controverted problems in geology, because geological maps of mountain areas are most difficult to prepare, and the interpretation of mountain structure involves appeal to layers of the crust far too deep for direct observation. The American Geological Society has arranged a symposium of nine papers on the development of mountains,[1] which is the best available summary of modern opinion on the subject and illustrates its diversity.

The series opens by a masterly sketch by Prof. Schuchert of the development of research on orogeny from its foundation by H. H. Rogers, and of the evolution of North America, illustrated by 17 maps. He compares the American school with Haug's view of geosynclinals, which he rejects as untenable. Amongst several useful new terms proposed is "tafrogenesis" for rift valley formation.

Mr. Longwell's paper on Kober's theory is appropriate, as it deals with an extension of the subsiding belt explanation of mountain formation. Kober reclassifies the Alpine elements to avoid that asymmetry in mountain chains which Suess emphasised as their distinctive feature. Prof. Hobbs rejects Suess's arrangement of the Asiatic arcs, and assigns many of them to a direction of movement opposite to that adopted by Suess.

The structure of Appalachia naturally plays a large part in the symposium, and is discussed by J. B. Woodworth and Arthur Keith, whose conclusions are opposite. The former adopts isostasy, which Keith criticises adversely. He attributes the Appalachians to the intrusions of many granitic batholiths; in a valuable discussion of rival theories he rejects the shrinkage of the earth, owing to the astronomical disallowance of the necessary reduction in size; but if the geological evidence for the contracting earth is adequate the astronomers will doubtless find some reconciliation of that fact and their calculations.

The structure and building of the Rocky Mountains is discussed by G. R. Mansfield and W. T. Lee, whose paper is accompanied by appendices by C. E. Van Ostrand and W. D. Lambert. Mansfield rejects Kober's view that rift valleys are accompanied by compression, and insists that they are due to tension. Lee describes the Southern Rocky Mountains as due to vertical uplift in the restoration of isostatic equilibrium.

[1] Symposium on the Structure and History of Mountains and the Causes of their Development. Bull. Geol. Soc. Amer., Vol. 34, Pt. 2, June 30, 1923, pp. 151-380, 1 pl.

University and Educational Intelligence.

Cambridge.—As was reported some months ago, the Rockefeller Trustees offered to build a School of Pathology for the University, and to endow it partly, if the University could provide from other sources the sum of 33,000*l*. as a share of the total expense involved. It is now announced that Mr. Ernest Gates, of Norfolk, has offered the sum necessary to complete the 33,000*l*., and is thus enabling the University to accept the generous offer of the Rockefeller Trustees.

London.—A course of 24 university extension lectures on "The History of Science" will be given at Gresham College, Basinghall Street, E.C., by Dr. C. Singer, beginning on September 29. The first lecture will be free. A course of instruction in geography has been arranged for delivery at the Westminster Training College, Horseferry Road, S.W., to one year full-time students and four year part-time students. Particulars of these and other courses of lectures on science, geography, history, literature, economics, art, etc., may be had from the Registrar, University Extension Board, University of London, South Kensington, S.W.7.

Manchester.—In connexion with the department of Bacteriology and Preventive Medicine, a diploma in bacteriology has been instituted and a course of instruction for graduates in medicine or in science will be started in October. It is requested that intending candidates for the diploma shall send their names to the director of the Public Health Laboratory, York Place, Manchester, from whom further particulars can be obtained.

Oxford.—Applications are invited for two research assistantships in the Institute of Agricultural Engineering. Candidates must have had specialised training and experience in advanced physics and electrical engineering respectively. Particulars and application forms are obtainable from the Director of the Institute, 65 St. Giles', Oxford.

University College, Reading, and the Berkshire Agricultural Instruction Committee invite applications, up to September 29, for the post of Instructor in Beekeeping for Berkshire. Particulars may be had from the Agricultural Organiser for Berkshire, University College, Reading.

Applications are invited for the professorship of electrotechnics in the University of the Witwatersrand, Johannesburg. Particulars of the position and a form of application are obtainable from the Secretary, Office of the High Commissioner for the Union of South Africa, Trafalgar Square, W.C.2. Applications for the post and copies of testimonials must be sent to the Secretary by, at latest, September 30.

The Educational Directory, 1924, published by the United States Bureau of Education, containing some 15,000 names and costing only 20 cents, must be invaluable to educationists in the United States, and is not without interest in other countries. The names given are those of presidents, deans, superintendents, and other administrative officers, and there are useful lists of boards and foundations, libraries, associations, and periodicals. The extent to which the summer school system has developed in America is indicated by a list of nearly 900 summer schools.

Early Science at the Royal Society.

September 13, 1666. The Society being taken up for the most part of this meeting with the consideration of the place for their future meetings in that time of public disorder and unsettlement by reason of the late fire, was thereby hindered from making experiments, and discoursing of philosophical subjects, as they used to do.

1677. Ordered, that Mr. Boyle, Sir John Hoskyns, and Mr. Hill, or any two of them do at ten of the clock in the morning go to the widow of Mr. Oldenburg, late secretary of the Society, and demand, receive, or take order for securing, for the use of the Society, all such goods, books, and writings belonging to the Society, as were or had been in the possession of her, or of her late husband.

September 14, 1663. Mr. Oldenburg mentioned, that Mr. Beal was willing to engage in the observation of the weather, and in registering the changes thereof; and that he hoped to set the same at work in other parts of the country; desiring to be furnished with thermometers of the same figure and size. Whereupon Mr. Hooke was ordered to give the operator directions to provide a dozen sealed thermometers with spirit of wine, to be sent to Mr. Beal, and into other parts of the world.

1664. An account was given by the president of some experiments made on the top of St. Paul's steeple: 1. To measure the vibration of a pendulum of 200 feet long. 2. To discover the difference of the weight of bodies on the top of the steeple and below. 3. A repetition of the Torricellian experiment.

September 17, 1662. Sir Robert Moray mentioned a French gentleman, who having been some time in England, and being present at a meeting of the Society, took notice, that the nature of all trees is to run altogether to wood; which was changed by a certain method of cutting them, whereby they were made, contrary to their nature to bear fruit; and that according as this cutting was performed with more or less skill, the more or less fruitful the tree would be. A proposition was offered by Sir Robert Moray about the planting of timber in England, and the preserving of what was then growing.—Dr. Charlton read his discourse entituled "Apparatus Phonocampticus: or what inquiries are principally to be made by such, who would attain to the certain knowledge of the nature of echos," which was ordered to be entered into the book of histories and theories.

September 18, 1661. Mr. Croune produced two experiments, one of the compression of the air with quicksilver in a crooked tube of glass, the nipt end of which broke; and the other with a cork kept down at the bottom of a cylinder of water in a vessel perforated at the bottom, over which the cork was laid; upon stopping of which foramen, and the pouring in of water, the cork immediately rose.—Mr. Boyle gave an account of his having made the former of these experiments by compressing twelve inches of air to three inches, with about an hundred inches of quicksilver.

1666. Mr. Hooke showed his model for rebuilding the city to the society, who were well pleased with it; and Sir John Laurence, late lord mayor of London, having addressed himself to the society, and expressed the present lord mayor's and aldermen's approbation of the said model, and their desire that it might be shown to the King, the president answered, that the society would be very glad, if they or any of their members could do any service for the good of the city; and that Mr. Hooke should wait on them with his model to the King, if they thought fit to present it; which was accepted with expressions of thanks.

Societies and Academies.

PARIS.

Academy of Sciences, August 18.—M. Guillaume Bigourdan in the chair. Notice of the death of J. B. de Toni, Correspondant in the section of botany.—F. E. **Fournier**: Remarks on the interpretations to be given in future to the three special signals defined in the author's note on safety manœuvres for steamships passing each other in fog, published in the *Comptes rendus*, August 4.—S. **Winogradsky**: The microscopic study of the soil. A detailed description of the technique adopted for the direct observation of the soil bacteria, together with a short account of the results obtained.—E. **Mathias**: The noise of the lightning flash. The theory is propounded that the electrical discharge produces endothermic compounds of oxygen and nitrogen of the type O_4, N_4, O_6, N_6 and that the noise of the flash is produced by the explosive decomposition of these substances. According to this theory the flash and noise are not produced simultaneously. No experimental evidence in support of the theory is given.—Charles **Nicolle**: Contribution to the knowledge of obscure infections. Examples drawn from the experimental study of exanthematic typhus. The term *infection inapparentes* is given to a type of acute septicæmic infection, existing exceptionally in the guinea-pig and frequently in the rat. There is no rise of temperature, and the existence of the disease can only be recognised by inoculation into other animals: the condition is quite distinct from what has been termed latent infection.—H. **Mineur**: The analytical theory of continued finite groups.—M. **Paschoud**: The problem of uniform regime in a fine tube the section of which is an isosceles right-angled triangle.—Carl A. **Garabedian**: Four methods for solving the problem of the rectangular beam.—Antonio **Cabreira**: The determination of geographical latitude, any three altitudes and the declination of the star being known.—Ernest **Esclangon**: The total eclipse of the moon of August 14, observed at the Strasbourg Observatory.—L. **Dunoyer** and P. **Toulon**: Some electro-mechanical applications of arc relays with external sheath.—Carl **Benedicks**: Method for the determination of the density of iron and of other refractory metals in the liquid state: an extension of the hydrostatic method of Dulong and Petit. The density of liquid iron at 1540° C. was found to be 6·92±·07.—C. **Gutton** and G. **Laville**: Electrometric measurements of very small alternating potential differences.—R. **Bureau** and A. **Viant**: Meteorological conditions and the appearance of certain atmospheric disturbances in receiving apparatus of wireless telegraphy. Atmospherics are always connected with invasions of polar air and are removed by the arrival of a warm front.—André **Graire**: The reversibility of the reactions of sulphuric acid formation in leaden chambers. Evidence of the reduction of sulphuric acid to sulphur dioxide by nitric oxide, reversing the ordinary reaction forming sulphuric acid in the leaden chamber.—Mme. Pauline **Ramart**: Molecular transpositions. Identification of the products of dehydration of 1.1.3-triphenyl—2.2-dimethyl—1-propanol.—H. **Gault** and B. C. **Mukerji**: The formation of hydrocellulose.—G. **Vavon** and A. **Couderc**: The isomerism of menthol and neomenthol. The addition of hydrogen to menthone, in the presence of platinum black, gives a mixture of stereoisomers in which neomenthol (cis) predominates over ordinary menthol (trans).—R. **Fosse**, Ph. **Hagene**, and R. **Dubois**: Researches on a new method of quantitative analysis of cyanamide in its calcium compound.—P. **Nottin**: The estimation of maltose in the presence of other reducing sugars by means of Barfoed's solution.—Alfred **Schoep**: Sklodowskite, a new radioactive mineral. This was found in the Belgian Congo, in a layer containing several uranium minerals. Its composition is $MgO . 2UO_3 . 2SiO_2 . 7H_2O$ and it has tellurium, nickel and alkalies as impurities.—R. **Verneau**: Recent prehistoric discoveries in Indo-China. These deposits were found in caves in the Bac-Son limestone massif, and have furnished several thousands of stone implements.—L. **Blaringhem**: The degenerescence of flax.—L. **Emberger**: Contribution to the study of the formation of plasts in plants.—G. **Ramon**: The properties of diphtheric anatoxine. The anatoxine, the preparation of which was described in an earlier communication, retains its immunising properties for long periods (twelve months) if kept in an ice box (3° to 4° C.). Keeping does not develop any toxicity, and the properties are unchanged after heating to 65°-70° C. for one hour.—— **Simionesco** and André **Lancien**: The influence of the cinnamic radicle on the stimulation of the hæmatopoietic organs.

Official Publications Received.

Agricultural Experiment Station, Michigan Agricultural College. Special Bulletin No. 125: Michigan Potato Diseases. By G. H. Coons and J. E. Kotila. Pp. 55. Special Bulletin No. 129: Bean Growing in Michigan. By J. F. Cox and H. R. Pettigrove. Pp. 21. Special Bulletin No. 130: The Clovers and Clover Seed Production in Michigan. By J. F. Cox and C. R. Megee. Pp. 23. Special Bulletin No. 131: Tomato Growing in Michigan. By E. P. Lewis. Pp. 14. Special Bulletin No. 132: Common Pests of Field and Garden Crops. By R. H. Pettit. Pp. 60. Technical Bulletin No 63: Studies on Michigan Celery Diseases. 2 · A Study of the Early Blight Fungus, *Cercospora apii* Fres. By L. J. Klotz. Pp. 43. Circular Bulletin No. 62: The Simplex Lime Spreader. By H. H. Musselman. Pp. 7. (East Lansing, Mich)

Proceedings of the Aristotelian Society. New Series, Vol. 24: Containing the Papers read before the Society during the Forty-fifth Session, 1923-1924. Pp. ii+272. (London: Williams and Norgate.) 25s. net.

University Correspondence College. London University Guide and University Correspondence College Calendar, 1924-1925. Pp. 204. (Cambridge: Burlington House; London: 34 Red Lion Square, W.C 1.) Gratis.

A Catalogue of Scientific Periodicals in Canadian Libraries. Prepared by Dr. Gerhard R. Lomer and Margaret S. Mackay. Pp. xx+255. (Montreal: McGill University.)

Diary of Societies.

MONDAY, SEPTEMBER 15.

CONFERENCE OF ENGINEERING SOCIETIES (at the British Empire Exhibition), at 10.30.—Miss C. Griff: The Working of Stainless Steel.—A. R. Page: Co-operation between the Works Chemist and the Engineer.—T. G. Hunter: Ceylon Plumbago—Its Uses and High Qualities.—A S E. Ackermann: Technical Popular Fallacies.

TUESDAY, SEPTEMBER 16.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—Dr. C. W. Saleeby: Light and Life.

THURSDAY, SEPTEMBER 18.

CERAMIC SOCIETY (Refractory Materials Section) (at the British Empire Exhibition).—T. W. Barley: A Comparison of Gas and Coke Fired Drying Stoves, together with a Description of the Construction and Operation of the Huttenes Coke-Fired Air-Blown Furnace.—Prof. J. W Cobb and H. S. Houldsworth: Some Properties of Clay Sillimanite Mixtures.—W. Hugill and W. J. Rees: The Influence of Exposure on the Chemical and Physical Properties of Certain Fireclays.—W Vernadsky: The Action of Heat on Kaolinite and Kaolinitic Clays.—W. J. Rees: Alumina-Silica Minerals in Firebricks.—Dr. J. W. Mellor and A. Scott: The Action of Heat on Kaolinite and other Clays, Part II.—A. Scott: The Origin of the Austrian Magnesite Deposits.—A. Hadding: X-ray Investigation of Clays and other Ceramic Substances: Researches into the Application and Practical Value of the Method.—W. J. Rees: Note on the Storage of Silica Refractories.—W. J. Rees: The True Specific Gravity and After Expansion of Lime-bonded Silica Bricks.—W. Hugill and W. J. Rees: A Rapid Method for the Determination of True (or Powder) Specific Gravity.

FRIDAY, SEPTEMBER 19.

CERAMIC SOCIETY (Refractory Materials Section) (at the British Empire Exhibition.—(For Papers to be communicated see above.)

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—*Red Book* Night (Affiliation of Photographic Societies with the Royal Photographic Society). The slides selected from the Affiliation lantern slide competition will be shown on the screen, and a criticism on the slides will be made by S. L. Coulthurst.

Supplement to NATURE

No. 2863 SEPTEMBER 13, 1924

The History of Scientific Thought.

By W. C. DAMPIER WHETHAM, F.R.S.

THE earliest form of history is a chronicle of priests and kings with their attendant worshippers and warriors. The misty dream of god-descended heroes passes into the clear vision of the ordered march of Roman legions; the picturesque pageant of medieval bishops and barons vanishes in the smoke of Bosworth field; and the sound of Drake's guns, drumming the Spaniards up the Channel, melts into the strains of a Te Deum, sung in Notre Dame for another victory over Marlborough.

Then Clio discovers politics, and tells us of statesmen and of constitutions. Pericles and Cicero, Richelieu and Walpole, Magna Charta and the Petition of Right, the Declaration of Independence and the French Revolution (with appropriate footnotes on contemporary literature and art), are acclaimed as the proper study of mankind. The old idea of a Garden of Eden or a golden age of heroic kings in the past changes into the equally pathetic delusion of certain and continued progress in the future, necessarily linked with the growth of political democracy in the present.

So historians taught when our fathers were young. Then came Thorold Rogers and William Cunningham, who first saw the importance of economic history, while Maitland was putting new life into the chronicles of Law and Constitution by the study of records. Underlying the froth and glitter of politics and war, we were shown the deep and steady currents of economic change. Control of the trade routes of the ancient world, the rise of European prices due to the gold of Mexico and Peru, the coal of England burning into power in the pioneer factories of the world, were realised as more mighty than the beauty of Helen or the valour of Achilles, the will of Popes or the ambition of Kings, the genius of Napoleon or the lure of Reform Bills. And the believers in sudden Utopias, disillusioned by this time of political reform, hastened to become economic socialists.

But now men begin to ask how these resistless currents of economic change are started, and what determines the channels in which they flow. It is clear that our varying control over the resources of Nature is one factor involved. When bronze could be used instead of stone and flint, when fresh-forged iron replaced the softer bronze, new industries appeared, and the efforts of men were perforce turned aside to develop and exploit them. The making of gunpowder pierced the knight's bright armour and levelled the baron's frowning walls, to spread abroad the King's peace and liberate the trade of towns. Tull's discoveries in the art of growing field-crops, and Bakewell's study of the methods of stock-breeding, gave food for the rapidly growing population, called into being by the energy of coal, converted in the factories built to meet the inventions of Watt and of Arkwright.

This harnessing of Nature's fiery steeds of power is one of the two functions of that ordered knowledge we call science, and, conversely, the material wants of man give one of the two motives from which pure as well as practical science springs. Geometry arose from the need for the repeated mensuration of land after the yearly flood of the Nile; astronomy began as the bye-play of Chaldean astrologers, seeking, by the dim light of the stars, to peer into the future and thus control the destinies of man; thermodynamics was developed to explain and improve the working of the steam-engine.

But another desire is also at work to generate science, and another function is fulfilled by science when born. Man does not live by bread alone. The longing of the soul for light, of the brain for knowledge, is a nobler if a rarer instinct than the craving of the body for food and shelter. The mystery of existence, the eternal riddle of the Sphinx, moves the mind of the philosopher, and, when he learns to humble his hopes and advance step by step on the slow road of observation and experiment, he becomes a man of science and gains an ever-increasing insight into the secrets of Nature.

So it is that history, to become a complete record of man's story, must take account of his intellectual as well as of his material achievement. Thus alone, when the history of thought is combined with that of action, can we watch in its fulness the great human drama, and write in worthy form a Universal History of the World.

Moreover, to do this as it should be done, we must call to our aid the transforming magic of literature. Our poets must not only sing of burning Sappho or the hills of Rome, of Ivry or of Waterloo, of fights for

freedom or of legal progress broadening down from precedent to precedent. They must tell us also of Newton and of Einstein; of the busy laboratory and the mountain observatory; of the spiral nebula whirling from its arms new stars into the dark abyss of space, and the hundred million years of organic evolution; of the lion-haunted dreams of early cave-men, the rise and fall of succeeding civilisations in the long history of the world, and the majestic march of modern knowledge—perhaps but starting on an illimitable progress towards the moral and material betterment of all mankind, perhaps doomed to check and dissolve once more amid the social and economic dangers of our great democratic experiment. There is romance enough in the story of the past, in the veiled mystery of the future, to give a theme worthy of Shakespeare or of Sophocles.

This vision of science as the uniting link between the intellectual and the practical efforts of man, the worthy subject of history and of literature—a vision hitherto seen by few—is at length becoming clear to many. Darwin fluttered some ecclesiastical dovecots; but now for thirty years a cumulative series of striking discoveries has awakened the imagination of all educated men. Röntgen's X-rays, the sub-atomic electron of Thomson, the radioactive disintegration of matter revealed by Rutherford, are paralleled on the biological side by the tracing of the source of malaria, the detection of vitamins, and the application of Mendel's researches to the breeding of new varieties of cereal crops. The War enforced the lesson. Victory was impossible without the aid of the physicist, the chemist, the biologist, and the engineer; and peace cannot bring prosperity and contentment until the electrician has led power about the land, and the economist taught us how best to use and distribute its products.

We see, therefore, a great quickening of interest, not only in contemporary science and its possible applications, but also in the story of scientific development in the past and in the lives of those who have made it. We need but turn over the pages of NATURE for the last few years to see what a change has taken place. Book after book has recently appeared dealing with some aspect of this wide subject, and NATURE itself has helped, both by notices in its editorial columns and by such serial publications as the Calendars of Scientific and Industrial Pioneers and the abstracts of Early Science at the Royal Society.

The universities and schools also are showing more interest in this aspect of science. Mr. R. T. Gunther, led by a chance finding of a collection of apparatus "locked up in a dark cupboard in Christchurch, all smothered with the dust of ages," is publishing a series of studies of early science at Oxford, and Dr. and Mrs. Singer carried on notable research there on the history of science, especially on the biological and medical side, before they moved to London, where a University course of study in the history, principles, and methods of science, leading to an M.Sc. degree, has been established. Sir Clifford Allbutt gives occasional lectures at Cambridge on the history of medicine, and Sir Arthur Shipley on the development of biology.

In schools, nearly all boys now learn some science, and, both for those who are specialising in it and for those whose main intellectual interests lie in other fields of thought, it is well to gain some knowledge of the course of its growth, even to read some of its classical writings. The reports of the yearly conferences of schoolmasters show an increasing appreciation of the advantages of this mode of treatment.

Education is searching for a way of presenting the new humanism. When the works of the writers of Greece were rediscovered at the Renaissance, they were welcomed, not only as history and literature, but also as containing philosophy and science far in advance of anything then known to the modern world. It was natural and right that school studies should be founded on classics, and a classical education was then, and until recent times, the best available. It survived its usefulness, and the inevitable reaction brought into prominence a somewhat academic treatment of mathematics, and a rather inhuman and too odoriferous science. Such studies could not give a complete education, and a tendency to emphasise once more the benefits of classics became manifest.

Science, however, has now reached heights and depths far beyond those that could be touched by the Greeks, and philosophy in the light of science has assimilated the best part of Greek thought and passed on. History and archæology trace the rise and fall of five or more civilisations, in which that known to Herodotus and Livy is but the last before our own, and possess a wealth of records in which a student may learn the delight of research at first hand. The literature of Europe in the last three hundred years can show masterpieces not unworthy of ancient times, and the Gothic cathedral is as noble a building as the Athenian temple.

It is essential to train modern youth to understand and appreciate modern action and modern thought, and a modern humanism is now possible which views classical learning in its right place in a greater whole. In that humanism the history of scientific thought fills a worthy place, and, with a more intensive study of some science itself, may give that open mind and spirit of reverent inquiry into truth which is the essence of scientific method, and the best object of a liberal education.

Science and Literature.

THE rather widespread feeling that science and literature are, in some way, opposed to one another seems, at first sight, inexplicable. For we can say that science is merely a way of ordering experience in terms of certain fundamental principles and concepts, and that literature is a way of ordering experience which employs different principles and concepts. Opposition could arise only if one of these methods professed to be exhaustive and declared that there was no room for the other. But science certainly does not make that claim. No scientific man asserts that the comprehension of a certain region of experience that is given to us by Shakespeare's plays is contained in any scientific treatise, and although we are frequently told that some poet or philosopher has anticipated some great scientific theory—*e.g.* Einstein's—it is probable that this statement is not intended seriously. Yet it is true that there are many literary men who regard science as if it were, in some way, opposed to literature.

There seem to be various reasons for this attitude. In the first place, it is becoming increasingly obvious that a literary education is only half an education. It is still possible for the writing of a poem or the writing of a novel to be referred to as "the highest of human activities," but the statement is not now so generally believed. An increasing number of people are beginning to believe that the creation of a great scientific theory may be as great and significant an achievement, as high an activity, as the creation of a great work of pure literature. From this human, all too human, point of view we can quite imagine that some literary men find science a sort of rival, and a dangerous rival, to literature. But we must admit that this explanation covers only a small part of a widespread attitude. A more important element in the "opposition" to science is due to the dislike of the materialistic philosophy with which science was, until recently, supposed to be associated.

That the scientific man is a dull materialist, insensitive to beauty and incapable of profound emotions, is, or has been, a commonplace amongst literary artists. A botanist, as is well known, is a man who knows everything about a flower except that it is beautiful. That these purblind creatures have an inordinate appetite for facts, and a curious, abnormal "cleverness," is freely admitted. But since they are blind to everything that makes life to other people worth living, know nothing of the artist's raptures nor of the hopes and despairs of passionate natures, believe that nothing is real except what they can put in a test-tube, they must be treated, as Nietzsche says, as mere instruments. They are more costly and exquisite versions of their own galvanometers and spectroscopes. In the great company of prophets, seers, and poets, they have no place. They are merely measuring machines, to be made use of by their betters.

This is Nietzsche's view and it is not uncommon. Is there any justification for this view? It must be admitted that some scientific men almost warrant the caricature. It is a peculiarity of science, as distinguished from the arts, that valuable results can be achieved by mere industry. The possession of a telescope, and of an abnormal capacity for sitting still, have sometimes made their owner immortal. It is true that eminence in science can sometimes be achieved by a man without insight, without imagination, by dint of the unexciting virtue of conscientiousness. Valuable as these men are to science, they have no perceptible existence except in conjunction with a laboratory. To the literary man, for whom greatness is almost synonymous with the capacity for experiencing and expressing profound emotions, the eminent man of science may be a negligible human being—"a mere specialist." It is appropriate that such a being should adopt materialism as a philosophy. He finds nothing in his own soul which seems unlikely to be the outcome of the mutual impacts of little billiard balls, and, being unaware of his narrow limitations, he suggests that this hypothesis will cover everybody's experience. To some of the greatest literary artists of the nineteenth century, scientific materialism, as it was popularly understood, was the final proof of the inadequacy of the scientific mind. It is unfortunate that science is so technical, for it means that non-scientific people cannot distinguish between the great creator and the merely industrious worker, and that only a debased and distorted version of a scientific theory gains currency amongst them.

But while the contempt for and dislike of science manifested by such great artists as Tolstoy and Dostoevsky was largely founded on a misapprehension of what science is, the change which has occurred in the attitude of literary men towards science is certainly connected with the fact that materialism is no longer so vehemently preached by scientific men. Such great scientific theories as the electrical theory of matter and the theory of relativity have finally destroyed, it is felt, that old Victorian mechanical universe, with its "iron laws." The universe has become "enjoyable," in Maxwell's sense of that word when he says that the necessary condition of the enjoyable is that the mind

should believe in the existence of a law and yet have a mystery to move about in. In the new universe of science the poet feels that he has room to exist. Such feelings are not, perhaps, based on reason. It might be difficult to justify them, but even the man in the street feels that the "atmosphere" of the modern scientific universe is very different from that of the universe of, for example, Haeckel. For this reason there has been a change in the literary man's attitude towards science. He is even willing to admit that scientific men of Einstein's rank may, in virtue of their imagination and passion, be ranked with great artists. But although a scientific man may be ranked as an artist, there remains an essential difference between a scientific work and a work of art.

That a scientific treatise may be exceedingly well written nobody will deny. That scientific men may show a delicate and catholic taste in literature, or, indeed, in any art, is also quite true. But it does not follow that a scientific treatise, however well written, can ever rank high as a work of literature. It seems that one criterion of the greatness of a literary work is its "immortality." To achieve this it must deal with subjects of permanent interest, and its presentation of them, although it may not be exhaustive, must be of such a kind that it cannot be superseded. Even where the ostensible subject-matter is of comparatively little interest, the real subject-matter—usually the personality of the author—has this quality. Very few people are interested in the subject of urn-burial, but many are interested in Sir Thomas Browne's unique reflections on that subject. Now it is of the essence of the scientific treatise that it deals with the transitory, for it is of the essence of the scientific conception of truth that science can continually advance; and it happens that a scientific argument is not a favourable medium for the expression of the most generally interesting characteristics of an author's personality. Even the best written of scientific treatises, and written by the best scientific men, such as the Dialogues of Galileo, have no longer the living interest that much older works of literature possess.

The reason is not difficult to discover. This apparent weakness is due to the very strength of science. Science is universally communicable and verifiable, or it is not science. It makes appeal, therefore, to just those faculties and interests that are least individual in men. It is impersonal, as we say. A scientific theory is an interpretation of experience which is valid for all minds precisely because it is not concerned with experiences which are individual. A scientific man has, potentially, all rational creatures for his audience. The artist can make no such claim, but he penetrates to a greater depth. At present the greater part of every man's experience lies outside the scientific picture and, for the majority of men, is by far the most interesting part of his experience. The arguments for the belief that the sun goes round the earth, however wittily presented, are of little interest now except to psychological historians. But human nature has changed much less than scientific theories, and a presentation of unrequited love, or of goodness triumphant in adversity, can still be pertinent to present problems and has lost nothing of its illuminative power for being centuries old.

This is not to say, of course, that the deepest human passions are not concerned with science. Kepler, in describing his triumph at his discoveries, wrote some of the finest passages in literature, but those passages describe his emotions, not his discoveries. They convince us that science may require the highest and deepest emotions for its service, that a great man of science may truly be a great artist, that he may give to science a passion and creative imagination that other men give to religion. But that does not make his problems eternal, or of permanent interest. The fate of a scientific treatise, as Huxley has said, is to be part of the rubble which forms the foundation of the new building.

The distinction between the scientific treatise and the work of literature, therefore, is connected with the old question of matter and form. What Shakespeare has to convey cannot be otherwise conveyed, but a student may fully master Lagrange's conception of dynamics without having read one line of Lagrange. There is, then, an essential difference between science and art, and, however far science penetrates into regions of experience it has scarcely yet touched, there will always remain an essential difference. This does not mean that the artist can ignore science. As a matter of fact, the scientific outlook affects literature by influencing the artist's emotions. Darwin's theory, for example, has had a great influence on modern literature. The influence of science is indirect; it is an important factor in shaping the *Zeitgeist* that prevails at any given time, and so influences not only the arts, but also philosophy and religion. But there can be no opposition between science and art except in the sense that the artist may feel himself to be in rebellion against the spirit of his age, a spirit largely due to the scientific outlook current in his time, or more probably, that was current a generation or two before his. The artist, therefore, does not ignore science; the fact is, he cannot escape it. When, however, he concerns himself merely with the expression of scientific fact or theory, and not with the spirit of quest and discovery, the chords he strikes must fail to find universal response in the human heart.

World List of Scientific Periodicals.

By F. W. Clifford.

It is difficult to conceive a publication which would be of greater value to scientific workers in Great Britain than that which is the subject of this article. Research workers in the realms of science, constantly confronted with references to periodical publications to which they have not immediate access, have often expressed the need for an authoritative list of scientific journals, together with an indication of the British libraries where they can be consulted. In the absence of this information, provincial workers are compelled to spend money and ill-spared time in journeying to and from London for serials which may perhaps be contained in a library nearer at hand.

Such a project has frequently been discussed and even commenced. The Panizzi Club, composed of senior officers of State, Universities, and Professional Libraries, got well ahead with a Union list in the early months of 1914, but the War intervened and the work so well commenced by Mr. E. W. Hulme, then Librarian of the Patent Office, came more or less to a standstill. This earlier effort was practically forgotten, when, in 1921, the need for such a list was again urgent, and the Conjoint Board of Scientific Societies appointed a small committee to devise a practical scheme for the compilation and subsequent publication of a World List of Scientific Periodicals.

The Trustees of the British Museum were approached, and recognising the importance of this work to scientific research and bibliography, they consented to allow the compilation to be undertaken by the staff of the Museum.

With this very material assistance, and financially fortified by the private guarantees of two well-known men of science, the Conjoint Board felt able to proceed with the proposal. Fortunately, at this critical period, however, the Carnegie United Kingdom Trustees expressed their willingness to add a substantial guarantee if the original scope could be somewhat widened. This action very considerably smoothed the way, and steady progress was made with the List. When the Board itself was dissolved in 1923, the original Committee was formed into a Limited Company so as to ensure the publication of the completed work.

It is intended that the List shall be issued in two parts. The first part is now in the press and will probably be published during the present year. This portion consists of a list of more than 25,000 scientific serials in existence in 1900, or originating between that date and the year 1921, whether still current or not.

Each serial is arranged alphabetically under its title, *e.g.* the Philosophical Transactions of the Royal Society will be found under " P " and not under " Academies, London." The items are numbered consecutively, and these numbers will be used in Part II. to identify the periodical. It will be recognised that in the arrangement of a list of this kind there may be several opinions as to the precise order which should be followed. The fact, however, that Prof. A. W. Pollard, until lately the Keeper of Printed Books in the British Museum, has acted as the editor, should more than guarantee that the final decision has been made in a manner which should meet with the approval of the bibliographer and fulfil the requirements of the scientific worker, whose references to periodicals are so often in a very abbreviated form.

The second part, or Index Section, will indicate in what libraries in the United Kingdom a copy of any of the serials in Part I. can be consulted. Sets of the sheets of the first part are now being circulated amongst important libraries, general and special, both in London and in specified provincial centres, for the addition of this information.

In the provincial centres the aid has been enlisted of certain professors and librarians, who are acting as local secretaries to co-ordinate the information as to periodicals taken in their respective districts. This laborious, but most valuable, work has to be carried out promptly, or otherwise the publication may be delayed. At a later date, perhaps, it may not be out of place to disclose the names of these enthusiasts, to whom scientific workers will always be indebted.

It may be well to mention that the World List is not intended to be a catalogue of the periodicals in any given library. A moment's thought will show the practical impossibility of giving all the libraries containing English journals of considerable circulation. In the case of these, the local secretaries have been asked to exercise discretion as to whether there is any need to indicate the existence of more than one complete set in their town. It would, however, be easy for any centre to use the World List as a catalogue of periodicals in that area by the simple means of stamping with a rubber stamp opposite each periodical possessed by the individual libraries comprising it. Or, as Part I. of the World List is printed on one side only, the entries could be cut and mounted on cards.

The List should also be of service in encouraging co-operation between large libraries in the direction of lessening duplication in their immediate neighbourhood, with the result that funds may be released for the purchase of additional periodicals, and in consequence increase the total number of periodicals contained in that area. At the same time such a survey would

show those responsible, how well, or ill, the research worker is catered for with regard to periodical literature in the respective institutions.

A comparison of the World List of Scientific Periodicals with the "Gesamt Zeitschriften Verzeichnis" shows that the former contains 25,000 whilst the German publication contains but 17,190. The French "Inventaire des périodiques," of which the first number has recently been issued, is not far enough advanced to ascertain the number of periodicals which will eventually be covered by it, but the letter "A" contains 2357 entries as against 2649 in the English production. No conclusion can be drawn from the latter figures, as the arrangement of the entries is not quite the same as that in the World List. Also the information as to libraries refers only to those in Paris itself.

This census of periodicals shows that the scientific journals are steadily increasing in number. Many new serials have commenced life since the War, and new Academies founded from patriotic motives are commencing to publish printed memoirs. Is it not time that a halt should be called? Would it not be possible for the older Academies to set an example by encouraging the publication of their own communications in the specialised journals? The scientific worker would then have his material more or less collected instead of contained in an academic "mixed grill." The researches would reach without delay those most interested, whilst details of abstraction, etc., would be very much simplified.

In conclusion, whilst no one library can be expected to contain all the periodicals mentioned in this monumental work, every library should at least contain a copy of the World List in order to direct inquirers to the nearest library where a particular periodical may be seen. Scientific research workers will in due time find that it is indispensable to them.

The Library Association's Subject Index.

SINCE 1915, "The Subject Index to Periodicals"[1] has been issued annually by the Library Association in the form of eight Class-Lists, except for the period 1917–19, when the lists were triennial. The Class-Lists are: A, Theology and Philosophy; B-E, Historical, Political, and Economic Sciences; F, Education and Child Welfare; G, Art and Archæology; H, Music; I, Languages and Literature (Part 1, Classical, Oriental and Primitive; Part 2, Modern and Bibliography); K, Science and Technology; L, Author Index to A-K, and List of Periodicals indexed.

The Index is a classification of articles of reference value selected from an examination of close upon 600 periodicals, English and foreign. The entries are minutely classified under the alphabetical subject headings of the Library of U.S. Congress, and are annotated where it is desirable to define with greater precision the scope of articles. The unbound numbers of periodicals sent for indexing are filed for reference and lending purposes. Any subscriber to the Index can on application obtain the loan of specified articles on payment of the return postage. Further, he can require the editors to furnish him with a list of articles under specified headings in continuation of the last printed Class-List.

Thus subscription to the Index on the part of a small rural or town library raises the status of that library to that of a research institution, for the Index places its readers in touch with the latest developments in thought, policy, and action in all departments of human life, while it maintains a library of serials for reference which is not only larger than the corresponding collections in the average municipal reference library, but probably also contains serials not to be found in the library of the British Museum itself. This work of the Library Association could not have been carried out without some external assistance. Generous pecuniary assistance has been forthcoming from the Carnegie United Kingdom Trust, while free quarters have been found for the editorial staff of the Index and its nucleus loan collection in the great National Library of Wales at Aberystwyth.

It should be noticed that "The Subject Index to Periodicals" was planned at a time when "The International Catalogue of Scientific Literature" was still in existence. Hence the Index was to a great extent designed to bridge the gaps which that publication left unfilled. With the discontinuance of "The International Catalogue," however, the question of the co-ordinated publication of indexes to scientific periodical literature once more comes to the front. This subject was brought before the Conference on Bureaux of Information and "Special" Libraries held at Hoddesdon on September 5-8. It may be taken for granted that international co-operation has failed and that the future organisation of scientific literature must be effected on a national basis.

Secondly, it should be remembered that the State has a well-defined interest in this matter, and should be called upon to shoulder its share of responsibility. For example, the principal repositories of the serial litera-

[1] Annual subscription, 4*l.* 4*s.* (Agents. Grafton and Co., 51 Great Russell Street, W.C.1.)

ture of art, education, science and technology are to be found in the State collections. In the case of many foreign serials, the only accessible copies are filed in these libraries, and naturally their curators possess the requisite qualifications for dealing with the highly specialised class of literature which they control.

Co-ordination in indexing requires the acceptance of a common scheme of classification and headings, and an agreed form of index entry. Further, the financial prospects of success under such a scheme are materially improved if the indexes produced are uniform in format and style and are published by a single agency. These conditions being granted, the actual indexing can be carried out in any home or library.

This method of indexing supplies a sound basis for development and negotiation. Any of the Library Association's Class-Lists could be split into smaller units —and some would no doubt benefit by such division, namely, B-E, historical, political, and economic sciences, and K, science and technology. A suggested inclusion of another 50 or 100 additional periodicals in any Class-List could be met if the State librarian, or secretary of the society in question, were prepared to supply the index entries and supervise or edit the extended Class-List. Any development in this direction would be welcomed by the Library Association.

The Index has now become practically self-supporting. It has been run by voluntary aid—one editor alone being in receipt of a modest salary. Finally, the Association has pledged itself not to treat any profits made by its publication as the property of the Association. Such profits will go either to a reserve fund or, more probably, towards the reduction of the price of its Class-Lists. It is scarcely necessary to add that the accounts of the Index are duly audited by a chartered accountant.

Reports of the Progress of Applied Chemistry. Issued by the Society of Chemical Industry. Vol. VIII., 1923. Pp. 618. (London: Society of Chemical Industry.) 12*s.* 6*d.* net, post free.

THE annual publication of these reports is not an event that evokes widespread interest or comment, yet the reports are always welcome to a goodly number of specialists. They are not original in the strict sense, because they are mainly compilations from the abstracts of original papers that have appeared during the year under review. Nevertheless they are very useful: they save the worker much valuable time; they instruct him concerning advances in branches of applied chemistry of which he has no expert knowledge; and if he believe what his testimonials state, that he has "a good all-round knowledge of chemistry," after reading these reports he will lose his conceit and confess his general ignorance.

The chief difficulty connected with publications of this kind is that the expert is too frequently a bad writer; and the chief defect is the absence of critical insight. It is, of course, no easy task to assess the value of developments that happened yesterday, but more attempts in this direction might usefully be made. Further, the reports would gain in lucidity—and the cost of publication could be materially reduced—if the phraseology were rigorously pruned; redundancy of expression and other forms of "journalese" are too common in the present volume.

A welcome feature in many of the reports is the inclusion of summaries of the trend of events in the economic sphere: a practice which should be extended, especially as there is now no single ephemeral publication which provides, regularly and systematically, information of this kind on all branches of industrial chemistry. The pending publication in the United States of *Chemical Reviews*, which will be issued quarterly and will deal with recent progress, may help to fill the gap which is now apparent in our chemical literature. If the reviews are critical and constructive as well as informative, the specialist may prefer them to annual catalogues of facts; but he will need, and should acquire, both. The comparatively small sale of annual reports of the kind we are used to is a distinct reflection upon English-speaking chemists, and no one will criticise the Society of Chemical Industry for maintaining in adverse times its expenditure on this useful publication, which falls well within the scope of its legitimate activities and of the wishes of its founders and benefactors.

Chemical Encyclopædia: A Digest of Chemistry and Chemical Industry. By C. T. Kingzett. Third edition. Pp. x+606. (London: Baillière, Tindall and Cox, 1924.) 30*s.* net.

WITHIN the last few years several works of this character have been published under various titles. Consequently the fact that the present volume has attained a third edition within a comparatively short time shows that it has supplied a well-defined want, and indicates that a knowledge of chemistry is becoming more and more indispensable to growing sections of our population, such as merchants, brokers, barristers, financiers, manufacturers of all kinds, pharmacists and the like. Chemistry is now so intertwined with almost all walks of life that probably every educated man at some time or other has wished to know something about a substance which he has found necessary for some purpose, and it is to such a class that the present book will appeal. He will here find a brief but clear account in non-technical language of almost every chemical substance that has attained any practical importance, with some of the principal constants inserted. Even professional chemists, who have access to exhaustive treatises on chemistry, will find the book handy for rapid reference, especially as it is clearly printed and attractively bound.

Some omissions are bound to occur in a work of this kind. For example, the well-known names "Westron" and "Westrosol" do not appear, although other preparations with a similar name and composition are mentioned. It would have been advisable to have stated that the basis of these non-inflammable solvents consists of chlorinated hydrocarbons, such as tetrachlorethane, trichlorethylene, and the like.

Studies of Scientific Development.

Isis: The International Review devoted to the History of Science and Civilisation. The official organ of the History of Science Society. Edited by Dr. George Sarton. (Weissenbruch and Co., 49 rue da Poinçon, Brussels.)

A FEW months back the formation of the History of Science Society, to carry on in a more permanent form the work which Dr. Sarton has been doing at the Carnegie Institution of Washington since the War, was announced in NATURE. The first volumes issued under these new auspices have just reached us and encourage the highest hopes as to the future of the enterprise. Estimated on the lowest basis, they are extraordinarily good value for the money, a subscription of five dollars covering the whole. Those who joined for this year will have already received two volumes, counting as Parts I., II., and III. of vol. 3. The first, besides various reviews, contains a longish article by Dr. Sarton himself, explaining under the title of the "New Humanism" the objects of the new association and its organ. It is, in fact, a programme and a confession of faith by the founder. The second is a full and very careful bibliography of all the books and articles which have been approved in the second half of 1923 on the history of science and philosophy and the history of civilisation. Its classification aims specially at bringing out the interdependence of the scientific development of different countries at the same time and thus illustrates the unity of mankind and the unity of knowledge.

The third part, however, is the review proper and contains this time a large number of articles interesting alike to the specialist and the general reader. Four languages are represented among the writers, six being English, three German, one Italian, while French occurs frequently, being the natural language of the editor and forming the bulk of his article on the Irish Walton, the aquiculturist of the middle of the thirteenth century.

Among many good things one may select two other articles for special comment. Both open up a rather unfrequented line of thought in Great Britain. The first is the "bio-bibliography" of Hunâyn Ibn Ighâg, the distinguished Arabian medical savant of the ninth century. This is by Dr. Giuseppe Gabrieli, the librarian of the institute in Rome for the study of Mohammedan science; it is intended to be the first of a series of such lives, which are greatly to be welcomed at the present moment when the relations between East and West are in a state of critical tension. The other article which specially attracts us is that by Prof. Lynn Thorndike, the learned author of the recent history of magic and experimental science in the middle ages. He treats in *Isis* of the history of science as it appears in the famous French Encyclopédie. He has studied the book carefully from this point of view and the results are somewhat unexpected. The encyclopedists are far less free from medieval prepossessions and errors than they thought themselves, or than posterity has supposed. They are far less violent against theology. But their strongest line was the history of industry and the mechanical arts. This was Diderot's own department, who was himself the son of a cutler. The article on the stocking knitting frame and its 2500 parts is ten times as long as that on cathedrals! When we remember that this was in 1751, before the steam engine, it would seem that we should regard Diderot as even more the prophet of the Industrial, than of the French, Revolution.

F. S. M.

Cambridge Readings in the Literature of Science: being Extracts from the Writings of Men of Science to illustrate the Development of Scientific Thought. Arranged by William Cecil Dampier Whetham, and his daughter Margaret Dampier Whetham. Pp. xi+275+8 plates. (Cambridge: At the University Press, 1924.) 7*s.* 6*d.* net.

IN these days many young students are apt to ignore or belittle the intellectual and practical achievements of bygone generations, and any book which deals in an interesting and accurate way with the stages that form landmarks in the development of science is to be commended. In the present work the authors have shown excellent judgment in their choice of extracts from the literature of science, and the explanatory introductions they have written to the extracts add considerably to the value of the whole.

The book is divided into three sections, of which the first traces the development of men's views on the structure of the universe, beginning with Genesis and ending with Eddington on "Space, Time, and Gravitation." In the section on the atomic theory are given extracts from Lucretius, Paracelsus, Dalton, Avogadro, Mendeléeff, Faraday, Arrhenius, J. J. Thomson, Aston, Moseley, and Rutherford, all of which appear to us to be particularly well chosen. The third section, dealing with evolution, contains, *inter alia*, selections from the writings of Aristotle, Lamarck, Lyell, Pasteur, Darwin, Mendel, and T. H. Morgan; it concludes with a somewhat dogmatic passage from Bergson to the effect that thought, being a product of evolution, will therefore never be able to grasp the true meaning of the evolutionary process. Some readers may demur to the inclusion of Bergson and the exclusion of Kant; others may think that quotations from Genesis, and speculations of thinkers before the dawn of positive science, are rather out of place in an anthology of the literature of *science*; but all will agree that the work as a whole has been excellently done, and that every student of science, whether in school or university, should be encouraged to read it and re-read it.

Social Science.

(1) *The Biological Foundations of Society.* By Prof. Arthur Dendy. Pp. x+197+17 plates. (London: Constable and Co., Ltd., 1924.) 7*s.* 6*d.* net.

(2) *Population and the Social Problem.* By J. Swinburne. Pp. 380. (London: G. Allen and Unwin, Ltd., 1924.) 15*s.* net.

THE student of social science may approach his task with either one of two objects in view. He may attempt to expose the permanent conditions upon which social evolution depends. He may, on the other hand, seek to deal with his material in much the same manner as systematists and morphologists have dealt with animals and plants. He may, in short, aim at the building up of a social morphology.

It is seldom denied that the adjective "scientific" is appropriate to studies of the first group. Under that heading falls the study, not of inheritance itself, but of the factors which are operating so as to produce changes in the germinal constitution of the race, and of factors which, given a knowledge of the conditions under which modifications are produced, can be detected in the process of impressing modifications upon each generation. Here also comes in the study of comparative psychology and the study of the manner in which the social heritage is built up, added to, passed on and lost: in other words, of the mechanism of the inheritance of tradition. The term scientific is, on the other hand, sometimes denied to studies which fall under the second heading. It is apparently held at times that they cannot be distinguished from historical studies which, by reason of the fact that they assume the form of a narrative and deal with the particular rather than with the general, are judged not to belong to science.

There are, however, grounds for distinguishing clearly between historical studies and scientific studies of social data. Not only may the latter, as also the former, be made with that detachment of outlook and accuracy in detail which characterises science, but also, in place of aiming at a narrative of particular events, they may aim at what Prof. Hobhouse calls a "descriptive synthesis." This may take the form of comparative social morphology, of the study of the trend of the evolution of an institution such as property, of an association such as the family, or of a particular civilisation. Between such studies, and those undertaken by systematists and morphologists in zoology and botany, it is hard to find any fundamental distinction, though it may be convenient to distinguish between "natural" and other sciences. The rate of progress in this field is slow, and while there may at times be grounds for the complaint raised by sociologists that their studies are not given the recognition which they deserve, it may not be out of place to remark that, if sociologists were to spend less time in discussing the scope of their science, what methods of investigation are appropriate, what the relation of sociology is to other sciences, and cognate questions, if in fact they were to get on with their task, recognition would come more quickly.

When workers in social science have firmly grounded and widely extended their studies, it may be some generations hence, a position may be reached not unlike that which faced Darwin when he surveyed the biological sciences in the middle of the last century. The systematists and morphologists had brought their studies to a point where the main outlines were clear and undisputed. It was then possible to apply to the facts so systematised what was known of the permanent conditions upon which organic life is based and to put forward a theory of evolution. So too in years to come, when enough preparatory work has been done, it may be possible to found a theory of social evolution which will show order and sequence in the data handled.

(1) The need of the time is for scientific research in both these directions. The temptation is to neglect spade work and to elaborate premature theories. It is here that Prof. Dendy's book is helpful. It may be described as a short and elementary course in general biology containing the minimum of biological knowledge that should be in the possession of all students of social science. Those who propose to pursue any branch of social science which falls under the first of the two divisions mentioned above will of course require far more detailed biological knowledge than this book can give. It will be to those whose interests and work lie in the other field that this book will be useful.

It is possible to do valuable work in systematic zoology and botany and to be almost entirely ignorant of general biology. But quite apart from the interest which a knowledge of general biology adds to these studies, such knowledge has a value in that it directs the worker's attention to many facts which he might otherwise neglect as unimportant but which, if recorded, may illuminate general biological problems. So too in studies of social data, some knowledge of general biology is not only interesting but also of great value. Had all those, for example, who have collected facts regarding existing primitive races had some grasp of biological problems, how much might they not have assisted indirectly in solving those problems by amassing data bearing upon them which, in the absence of biological knowledge, seem wholly unimportant? Or again, if attendance at a course in elementary biology was compulsory for those who are going to pursue that branch of social science known as economics, how much more definite and concrete would be their knowledge of the human material with which they deal. Prof.

Dendy's excellent little book deserves a wide audience among students of the various branches of social science.

(2) It is possible to study the population problem by attempting to lay bare the permanent conditions upon which it rests, or by collecting the facts regarding the control, density, or some other aspect of the problem under different conditions and then attempting to ascertain the trend of social development in whatever field is chosen. Mr. Swinburne's book is a disappointment in that, while written by a scientific man, it is not a scientific treatment of this problem in social science. From the book we learn what opinions Mr. Swinburne holds and what prejudices he harbours regarding most social questions of the day, including, for example, the relations between capital and labour, profit-sharing, the rights of man, government, the position of women, trade unions and socialism.

The connexion of all this with population is obscure, but those who disagree with Mr. Swinburne are asserted to hold erroneous views about population, though why they are erroneous, and what Mr. Swinburne's own views may be, are nowhere in the book logically and consistently set out. His reference to economists and their treatment of the population will serve as an example of his tone and style. "The curious point about economists' treatment of the population principle is that they never seriously discuss it or try to refute it." It is only necessary to recall that the fourth volume of the new Cambridge series of economic handbooks is wholly devoted to the population problem, and that a discussion begun by Sir William Beveridge at the Liverpool meeting of the British Association, and continued by Dr. Keynes and other well-known economists, has been occupying a very large amount of attention for more than a year in order to see the value of Mr. Swinburne's statements. All this work is entirely neglected by Mr. Swinburne. Can he have written a book of nearly 400 pages on population in ignorance of it, or, as the following quotations suggest, does he hold so low a view of the intelligence of economists that he does not read their works?

"There is no proper opening for economists, and no adequate inducement for men of first-rate ability to devote themselves to the study. The highest pinnacle an economist can reach is a professorship at some university or college. He may also write a text-book or two and there his career ends. . . . Generally speaking, an able man who can do anything else well has a strong temptation to leave political economy alone. . . . A man who might be a first-rate economist can do nearly as well in many other directions that give more return, and naturally he does so."

Whichever explanation is correct, the conclusion would seem to be that only those who are interested in Mr. Swinburne's prejudices will profit by reading his book.

A. M. C.-S.

India, and its Problems.

India: a Bird's-Eye View. By the Earl of Ronaldshay. Pp. xiii + 322 + 24 plates. (London, Bombay and Sydney: Constable and Co., Ltd., 1924.) 18*s.* net.

THE Indian Continent is such a vast agglomerate of different languages, different religions, and different peoples, not to mention varieties of climate and topography, that it is no easy matter to present it in a single view without a tendency to confuse and bewilder the reader who is not familiar with the various problems concerned. But Lord Ronaldshay is an experienced administrator who has had opportunities, on the staff of a Viceroy and later as the Governor of a great Indian province, not often enjoyed by those who have an inclination to write, and at the same time possess the pen of a ready writer. Further, he has devoted much time to the study of the history, religions, and archæology of India, in the course of which he has travelled much and has had personal experience of the scenes he describes so well. His position has necessarily brought him into contact with all that is best of modern India both in literary and political circles; so he is peculiarly well equipped to give a general sketch of the country, and in this he has acquitted himself as well as a difficult task permits.

In a chapter on "What the Buildings tell" the reader is introduced to the immense variety of architecture displayed in "the edifices raised over a vast span of time to the known and unknown gods of Indian belief," and the question is asked, Whence came the people who could produce such contrasts?

Thus we are led to the great gateways, on the North-West Frontier, in the mountain wall which hedges in and separates India from the rest of Asia, through which successive waves of invaders have passed, penetrating southward and eastward, bringing those Aryan races which have become the most numerous element. But one thing leads to another, so a description of the North-West Frontier, and its people, leads on to the ever-recurring problems connected with this troublesome corner of the Empire, especially those difficulties which have arisen owing to the no man's land existing between the British Administrative Frontier and Afghanistan. The story of our relations with the frontier tribes in recent years is told, and how, in spite of all our desires to the contrary, a forward policy has been forced upon us as the result of the climax brought about by the third Afghan War. We have now had to adopt a policy of permanent occupation in Waziristan, that is, provided the policy remains permanent, an important proviso. It may be ex-

pensive, but, probably, less so than the policy of repeated punitive expeditions, followed by withdrawal, which, under present-day conditions, requires an ever-increasing number of men to cope with the better armed, and better trained, tribesmen. Permanent occupation will go far to remove the economic causes of unrest on the Frontier, which lie at the root of most of our difficulties. We shall also be the better able to control those outside influences which have done so much harm in the past. Lord Ronaldshay's chapters on the Indian Frontier problems will do much to enlighten those who want to understand what these problems really are.

From the incursions from Central Asia the author turns to the last incursion which reached India by sea from the west. He gives a sketch of the well-known story of the rivalry among European nations, first for the possession of the trade of the East, ultimately for the possession of India itself, and the final victory of the British. As a typical example of operations in those early days he describes, in some detail, the battle of Plassey and a personal visit to the site which he made a few years ago.

In view of the present-day controversies which surround questions of the form of representative government best suited to India, all that Lord Ronaldshay has to say on the subject, in the two chapters on "Local Self-Government" and "The Indian Village," is of importance. Because we possess in a high degree the art of managing our municipal affairs by means of elective councils, it does not follow that such methods are suitable to the Indian soil. The author gives numbers of instances of failure of the elective principle. With the advent of the British, Western methods were forced on a people whose ideas of government are radically different from ours. If our methods are to succeed it will only be after a long course of instruction, and, as it were, acclimatisation. But we are not pessimistic as to the future of India, for we believe the British have an innate genius for overcoming these kind of difficulties, and finding a way out, though it may take time. One has a feeling that, on this subject, the author does not express himself as freely as he would like.

Two chapters are devoted to "Industrialism of the West" and "Wealth and Actual Potential." Like Western government, Western industrialism is distasteful to Indian ideas, and politicians have not been slow to make use of this fact. In England 80 per cent. of the population is urban, while in India 90 per cent. is rural, engaged in agricultural and pastoral pursuits. As a rule the Indian does not take kindly to factory life in the great industrial centres—his thoughts are in his village, to which he returns at the first opportunity. His heart is not in his occupation, and he often makes an inefficient workman. As a consequence, though wages are lower, a larger number of men are employed to produce a given article than in Europe, which often results in the Indian production being more costly than that which could be imported. The Indian politician, even Mr. Gandhi himself, though inveighing against modern innovations, is not above making use of railways and motor cars. Gandhi has made a dead set against European medicine, "which has been singled out for special attack," but by a curious irony he has recently undergone a serious operation at the hands of a skilful English surgeon who saved his life. One cannot help thinking this antagonistic attitude towards industrialism has more of a political motive than anything else, certainly among the extremists, merely because of its Western origin. In India one often hears the development of Japan applauded as an example of what an Eastern people is capable of achieving.

British future commercial relations with India must be free from the suspicion that we have any desire to exploit her. The author puts this point very well when he says: "It must be for the good of India that her wealth should be increased, and since outside aid is necessary to this end, what has to be done is to make it clear to India that the aid which Great Britain can offer her is given to the mutual advantage of the two countries, that if British business men look to receive a reasonable return themselves, they have no desire to deprive her of a reasonable share of the total profit. In other words, what they desire to do is not to exploit her to her disadvantage, but to co-operate with her in a business of mutual benefit."

Popular Hinduism is dealt with in a chapter describing some of those great religious festivals which play such an important part in Indian life, many of which the author has personally witnessed. When one considers the original meaning, and sublime conceptions, which have been read into some of these ceremonies, one is astonished at the wide departure from the original one sees to-day. It is not difficult to imagine the sceptic asking whether poets and thinkers in trying to explain away, by dint of allegorical interpretation, certain ceremonies, are not making ingenious attempts, though perhaps unconsciously, to put a fair complexion on practices which are not in accordance with modern ideas.

The concluding portions of the book endeavour to explain the reasons for the pessimistic outlook on life which apparently pervades the majority of Indians. This is attributed, partly to climatic and physical surroundings, which have enervated and saturated the people with malaria, and partly to the hopeless

religious doctrine of *Karma*, which lands those who believe in it in a tangled maze. The consequence of this doctrine, to the believer, is that "all existence in this world is suffering and sorrow"; the Hindu's ambition is not to prolong it but to escape from it. In these circumstances how can life be anything but a joyless existence? We are told of the measures which have been, and are being, taken to combat the evil of malaria, a most difficult matter when such a large area is concerned. These are based on the discoveries of Sir Ronald Ross and others, and are being carried out on a large scale, with ultimate benefit to the people.

Lord Ronaldshay always wants to get to the origin of things, and this adds enormously to the interest of what he has to say. Some of his pen pictures are delightful, as where he describes dawn on the Frontier; they vividly recall the scenes with which the Anglo-Indian is familiar.

It has not been possible to do more than touch on some of the topics with which this book deals. We thoroughly recommend it to all who would know about India; it is written in a pleasant style and is the result of much study and experience acquired on the spot. The reader will find something of interest on almost every page. H. L. C.

The Ascent of Man.

Making of Man: a Study in Evolution. By Sir Oliver Lodge. Pp. 185. (London: Hodder and Stoughton, Ltd., 1924.) 3*s.* 6*d.* net.

SIR OLIVER LODGE is unique among our men of science in commanding public attention on general and religious questions, as well as on the branch of science which he has made his own. Hence the little book before us will have a large audience, rather for its qualities of inspiration and feeling than for any definite contribution to its special subject. For on the biological side it is extremely scanty, and compares curiously in this respect with the volume of somewhat similar size and title from Prof. J. Arthur Thomson which we noticed a few months ago. The latter was from the pen of a biologist, this of a physicist, who has adopted with passionate conviction some highly speculative theories on psychical phenomena. But the book shows how perfectly Sir Oliver has learnt to use his great power of clear and simple exposition in the service of the religious propaganda which has now become the main interest of his life. The language is always effective and moving, though the sentiments are often obvious enough, and where he draws on his own province of physics, the illustrations are extraordinarily apt and sometimes beautiful. The concluding analogy of the Sun and the Divine is one of the best things of the kind we have ever seen.

But it is only fair to point out to intending readers that they must not expect a scientific treatise. For the shortest summary of the biological or sociological evolution of man, they must look elsewhere, *e.g.* to the little book by Prof. J. Arthur Thomson. Here we have rather a series of sermonettes, variations on the theme that the human spirit is an emanation of the Divine, that we may trace in its history clear evidence of an upward movement, that this movement is the result of continued effort, and that we can only attain a belief in "rational optimism," in the divine governance of the world for good, by seeing in this "effort" the necessary condition of any movement. It is here that Sir Oliver's physical analogies are most to the point. He shows in an early chapter how all change in movement involves force, and how all force implies resistance. This leads to the argument that evil is, philosophically considered, only the reaction implied in action. Things are not "done easily by nod, even by the Deity."

As the book thus becomes within its limits rather a philosophical, religious treatise than a scientific work, one would like to see some of these philosophical conceptions more deeply penetrated. But even this sense of insufficiency does not prevent a real outburst of gratitude and admiration for the veteran thinker and writer, who thus in the evening of his life puts forth such an inspiring exposition of his beliefs on the deepest personal questions which move us all; and, though he shows his own convictions on psychical phenomena by frequent reference to "the other side," he does not allow this prepossession to disturb the general argument. Men of all views, in fact, can find something to their advantage in the "Making of Man."

F. S. Marvin.

Prehistoric Times.

Ancient Hunters and their Modern Representatives. By Prof. W. J. Sollas. Third edition. Pp. xxxvi+697. (London: Macmillan and Co., Ltd., 1924.) 25*s.* net.

IT is nine years since the second edition of Prof. Sollas's "Ancient Hunters" appeared. The present book, although substantially the same in structure as the last, has been revised and brought up-to-date. New matter has been added involving the lengthening of the work by more than a hundred pages and the addition of several illustrations. In a rapidly developing subject like prehistory it is impossible to say that the last word has been written, but it can safely be prophesied that, in this revised and up-to-date form, "Ancient Hunters" will be for many

years to come an essential feature on every specialist's bookshelf, and will remain the best book to recommend to the thoughtful non-specialist reader interested in the subject.

As in the previous editions, the work opens with two chapters on quaternary geology and the antiquity of man. There follows a discussion of the thorny eolithic problem, where Prof. Sollas very judiciously sits on the fence, and next a description of the various Palæolithic cultures (here, perhaps, the specialist will regret the omission of the term Middle Palæolithic for Mousterian) interdigitated with accounts of what Prof. Sollas considers to be their modern counterparts—the Tasmanians, Australians, Bushmen, and Eskimos. The book concludes with a résumé of our knowledge of the chronology of Palæolithic times.

As regards the chapters on modern primitive peoples, while these are very illuminating to the specialist, perhaps a word of warning may be forgiven for the sake of the casual reader. Similar climatic conditions do no doubt produce a certain similarity of cultures when acting on more or less automatic humanity, but this must not be carried too far. Similar flint implements do not postulate similar ceremonies and modes of life. In the case of the Tasmanians and Australians, it seems positively dangerous to link those cultures in any way with that of early Palæolithic man in Europe, merely on the strength of there being a certain similarity in their stone tools. Although Mousterian culture apparently occurs in quaternary deposits in northern China, linked to that of western Europe by finds in southern Siberia and eastern Europe, it is a far cry from the prehistoric industries of northern China to those of the more or less modern inhabitants of Australasia. The same may be said of the Eskimos, though in this case a similarity in skull form has been adduced. With the Bushmen of South Africa, however, we are on safer ground. Not only are the tools similar but also the art—a much more conclusive criterion—is in some cases almost identical; compare the finds at the Barranco de Valltorta in east Spain with some of the Bushmen paintings—the technique is the same. Again, the Bushmen have a legend that they came from the north, and therefore probably from the same stock which supplied Neoanthropic man to western Europe.

In conclusion, one can have nothing but praise for this excellent third edition, the popularity of the predecessors of which has borne testimony to its worth. Prof. Sollas writes from first-hand information, having taken the trouble to visit personally the sites of discoveries so new that they had to be put in an addendum note at the beginning of the book. It is an open secret, that on receipt of a chance card, he posted without pause to the south of France and waded up to his waist in ice-cold water to see these new finds at Montespan. May this fascinatingly readable book, readable though information or material is never sacrificed to make it so, have the great success it undoubtedly deserves. M. C. B.

The Problem of Atlantis. By Lewis Spence. Pp. xi + 232 + 16 plates. (London: W. Rider and Son, Ltd., 1924.) 10*s.* 6*d.* net.

THE Atlantis problem affects so many departments of scientific inquiry that it is always with us. Mr. Lewis Spence, author of a series of books on the folk-lore of America and Egypt, is an enthusiastic champion of the existence of Atlantis, and of the historic importance of the Atlanteans. In this volume he conveniently collects the classical traditions on the subject and evidence from geology, biological distribution, archæology, and folk-lore, of a former connexion between Central America and the Mediterranean region by a transatlantic land.

There is much geological and biological evidence in favour of the existence of this land in the early and middle Kainozoic—a period, however, long before the age of man; but it gives no direct proof of large islands in the mid-Atlantic at the time required by the Atlantis theory. The direct land connexion between southern Europe and the opposite coasts of America must have been broken at the end of the Miocene; but there may have been surviving islands which have gradually foundered, just as Malta is a fragment of a land that once connected North Africa and Sicily, and has been reduced in size by repeated subsidences. If the rest were submerged, some ingenious critic might claim that the reports of Malta and its Phœnician population and its Knights of St. John were all an allegorical myth; and neither the geologist nor the biologist could refute him.

Atlantis may have been the remnant of a mid-Atlantic land which was inhabited by a cultured race that sent colonies into both the Old World and the New. The author claims that the Cro-Magnon race came from Atlantis and entered Europe from the west—a conclusion which would remove some difficulties. The direct evidence of the survival of Atlantis into the human period depends on the archæological evidence. Mr. Spence shows that the amount in common between Central America and Peru and the Mediterranean region is far more than can be explained by coincidence. He agrees, therefore, with Prof. Elliot Smith that the cultures of Egypt and tropical America were indebted to the same source; but he rejects the view that the connexion was established across the Pacific, owing to the absence of evidence of the Asiatic influences that should have been engrafted on the culture if it had passed from Egypt to America by

an eastward route. Mr. Spence recognises that the people of south-eastern Asia influenced those of tropical America; but he regards this connexion as independent.

The author is indiscriminate in his acceptance of anything that appears to support his views. Many of his arguments are unconvincing, such as the identity of the names Cleito with Coatlicue and of Atlas with Uitzilopochtli. He also accepts newspaper statements, which, though often useful as a clue, are not scientific evidence. Thus he remarks that the discovery in August of last year of a 2¼ mile rise in the floor of the South Atlantic in the course of the previous twenty-five years should make "the scoffer" revise his belief in the stability of the ocean beds; but the author's acceptance of this "mare's nest" may tend to make his readers scoff at a theory which accepts such statements without troubling to confirm them or even awaiting their contradiction.

L'Homme préhistorique dans l'Europe centrale: Primeval Man in Central Europe. By Prof. Dr. P. Goessler. Pp. 134 + 40 plates. (Stuttgart: Franckh'sche Verlagshandlung, 1924.) n.p.

IN this volume Prof. Goessler, Director of the State Museum of Antiquities in Stuttgart, has published a series of forty plates with descriptive letterpress, each dealing with a type of prehistoric man or of prehistoric culture, the type skull being figured with characteristic associated implements, ornaments, etc. The series begins with Heidelberg man and ends with the races of Central Europe of the present day. Students will appreciate the special attention which is given to the archæology of south-east Germany. The author has not, however, confined himself to Central Europe, and in the palæolithic age in particular the skeletal remains of early man from France and Britain as well as Rhodesian man are duly noted; but Piltdown man obtains no more than an incidental mention in connexion with the Galley Hill skull. In later periods, especially the bronze and iron ages, while the place of origin of German finds is, for the most part, carefully noted, in the case of many of the objects figured from other sources, this information is not given at all or only vaguely. The text is in German, French, and English, but the last-named is so bad as to be unintelligible at times without the original German, and shows almost complete ignorance of English technical nomenclature.

Man before History: a Short Account of Prehistoric Times. By Mary E. Boyle. Pp. 128+8 plates. (London, Calcutta and Sydney: G. G. Harrap and Co., Ltd., 1924.) 2*s.*

OF the total number of pages in Miss Boyle's little book, one hundred deal with the palæolithic period proper. The remaining 28 pages cover the Azilian, the Neolithic, the lake villages, the arts and crafts of the neolithic age, and the beginning of writing. This may seem a little out of proportion, but as her book is written for young people, her scale of treatment may be regarded as justifiable, especially as in this comparatively restricted space she has been able to indicate, at any rate in outline, the more prominent characteristics of the culture of the later period. She has wisely paid particular attention to the art of prehistoric man. Indeed, there is no book of this size and type which contains so many excellent reproductions of the cave paintings and the carvings as have been given by Miss Boyle. The later and less well-known art of Spain also receives due attention. Miss Boyle tells her story in a straightforward manner which is very much to the point. Within its limits this is an admirable little book and one of the best of its kind.

The Evolution of Man: Essays. By Dr. G. Elliot Smith. Pp. viii+159. (London: Oxford University Press, 1924.) 8*s.* 6*d.* net.

IN this volume Prof. Elliot Smith has reprinted three addresses—his presidential address to Section H at the Dundee meeting of the British Association in 1912, a paper presented to the British Academy in 1916, and a lecture delivered at the Royal Institution in the current year. Each deals with some one aspect of man's evolution, with particular reference to the specifically human attributes which evolve *pari passu* with the development of the brain. To them he has added a foreword in which he demonstrates with diagrams a tentative scheme of the relationships of the different genera, species, and races of the human family and a similar scheme of the relationship of the order of primates. In the former of these he puts forward what are undoubtedly very suggestive views on the problems presented by Eoanthropus and Rhodesian man. Prof. Elliot Smith has republished these lectures to meet the need for a consistent and coherent account of the essential factors in the evolution of man, pending the preparation of a more elaborate text-book, which, it is needless to say, will be heartily welcomed by all who are interested in this subject.

Origins in Place Names. By An Ignorant Student. VI.: *Life.* Pp. 7. (London: Privately printed at the Chiswick Press, 1924.) n.p.

ALTHOUGH numbered the sixth in the series, this is the fourth in order of publication of the pamphlets in which "An Ignorant Student" discusses the origin of place-names from various aspects. In this case his object is to link up place-names with the order of universal law by showing that they evolve logically from a conception of life as functional and the result of an arrangement and grouping of individual units. Just as from the leaf of a tree certain deductions can be drawn, it is possible to deduce from language, which is an expression of life, the country in which it grew and, on careful analysis, to arrive at the elements of which it is composed. The author's conclusion, therefore, is that among the earliest forms of language were the words, which we now call place-names, describing and locating the homes of the people who used them. This, if somewhat obvious, is no doubt true, provided a reservation is made in favour of the priority of certain other classes of words dealing with the personality and primary needs, such as food.

The Galapagos Archipelago.

Galápagos: World's End. By William Beebe. (Published under the auspices of the New York Zoological Society.) Pp. xxi+443+65 plates (9 coloured). (New York and London: G. P. Putnam's Sons, 1924.) 42*s.* net.

THE Galapagos Islands are situated directly on the equator, about 500 miles distant from Ecuador, which claims their sovereignty. They are volcanic islands, arising precipitously from a bank at 2000 metres, and their topographical connexion is with Costa Rica and Panama, 650 miles distant, with the tiny Cocos island between. They number 13 larger islands with numerous coastal islets, the largest island (Albemarle) more than 70 miles long, and they were formerly described as having 2000 craters. They are all volcanic, and every few years there are outbursts in one or other of them. Unfortunately they have no water, except what accumulates in pools in a short rainy season, so that the vegetation is relatively scant, except in selected spots, without that accumulation of broken-down rock and plant remains, which forms the rich soil of most tropical islands. Their shores are rocky in the extreme with cliffs and great boulders, and small inlets here and there, the sort of shore one is accustomed to expect on oceanic islands formed by submarine volcanic activity after the ash is washed away and the lava laid bare. Their surface is jagged rock with bushes and cacti in the crevices, so inexpressibly uncomfortable and thirsty that the interior of the larger islands would seem never to have been explored.

"A land pitted by countless craters and heaped into a myriad mounds of fragmentary rock; gnarled trees bleached by salt spray, with twisted, stunted branches; grotesque cactus stiffly outlined against black lava boulders . . ."

First the scene of the legendary adventure of an Inca king, then in 1535 explored for spices and gold by a Spanish bishop, later for almost 200 years the refitting station of buccaneers and whalers in succession, the Galapagos may now be described as almost a holiday resort for scientific expeditions. Chatham Island alone was inhabited as a penal and cattle station, the others almost untouched save for the ravages of pigs, goats, cattle, donkeys, and dogs on different islands. Dampier, that great exploring buccaneer, Porter, a raider on peaceful whalers, Darwin, a young ship's surgeon of twenty-six, and others, described them in terms which are generally correct to-day, so small are the changes produced by man.

The Californian Academy of Sciences, in an expedition under R. H. Beck in 1905, collected for almost a year and secured specimens of all sorts in such vast numbers that further collecting would seem unnecessary. However, in 1923 the New York Zoological Society adventured through one of its patrons, Harrison Williams, who took a party on board his yacht for a three weeks' cruise there. Beebe, one of the soundest of the United States naturalists and a most enthusiastic observer, was in charge, having W. M. Wheeler as entomologist and a party of twelve more including curators, artist, photographers, historian, preparateur, physician, and taxidermist. The object was clearly to get living animals for the Society, exhibition specimens for the Museum of Natural History at New York, and films and photographs of wild beasts, that still have no fear of man, for the general public. It was simply a scientific reconnaissance, extraordinary only in the quality and completeness of its personnel and equipment, and in these respects it may be described as "the last word." The immediate result is a readable book by Beebe, full of interesting observations, while Osborn contributes as florid an introduction, "In the Wake of Darwin," as we ever remember to have seen outside journalese, describing the expedition as "among the scientific wonders of our century"; "It is like rubbing the Aladdin's lamp of science," etc., terms which we would ourselves prefer to apply rather to the wonderful series of American palæontological results to which that author has himself been such an inspiring contributor.

Space permits reference to only a few of the natural history observations. We particularly like the accounts of the sea iguanas, up to 4 feet in length, in their vast numbers on suitable rocks, swimming by their flattened tails with hanging-down legs by which they cling for browsing on the seaweeds in the foam of the breaking waves and by which they drag themselves on land; the description of a crab crawling over one and picking off its ticks would not be believed if described by any other observer than Beebe. The mocking birds (Nesomimus), their habits and distribution, are scientifically interesting, once continental visitors, now perhaps species in the making in the different islets. A small penguin occurs, the only example north of the equator, and then there is the flightless cormorant, a bird one third longer with its wings 40 per cent. shorter than its nearest allies, as wonderful in many ways as the classic great auk, and like it, assuredly, doomed to disappear.

The huge southern sea-lions were generally so tame that the naturalists could approach and pick up their babies at will, their chief foes and those of the seals being rather of the water than of the land. Buccaneers and whalers came to the islands largely for the giant land tortoises, and the Californian Academy Expedition collected more than 250 specimens in which they recognised 15 species, separated from one another chiefly

on shape, with no real structural differences. They are known from 11 islands, each of which had one race, with the exception of Albemarle, which had several. All the evidence points to no interchange of tortoises between the islands, and the problem here, as in the Mascarene islands, is the method of their arrival, the evidence of any continuous land mass for their transport being equally small. Beebe only took one, and that from the bottom of a crater on Duncan Island; he found that it swam well and intelligently, this being against his views as to the necessity of a former land connexion with Costa Rica to explain the flora and fauna now existing in the Galapagos. At Albemarle they used to occur on the highest mountains, where there is much rank grass. A Guayaquil farmer started here a ranch to round up the cattle for their hides while the old tortoises were killed for their oil, few young, if any, surviving the depredations of the dogs. Whether any still exist in Albemarle is doubtful, and anyhow, unless there is some reservation, they will soon be known only as beasts of a past age. This is the fate which has befallen the land iguana on most islands, but Beebe found them still numerous in South Seymour. These lizards attained a length of 50 inches and live inland in holes which they scratch in the ground. They are vegetable feeders, their epicures selecting buttercup flowers and their gluttons cactus fruits and leaves with their spines and all, the former shaken down like apples from a tree. In fighting, unlike most large lizards, they use their jaws rather than lateral swishing movements of their bodies.

There is much else in Beebe's book to which we would like to refer: the finding of six bleached skeletons of the rare killer whale (Pseudorca), the capture of a species of Branchipus, many notes on the habits of birds, insects, and crabs, and a whole chapter on the life in rock pools. The impression we have gained is that, while there is no use for any more exploring expeditions, the Galapagos is still an immense field for the naturalist in the study of the mode of life and of the life histories of all the more lowly land forms. In particular, from a species point of view, the insects scarcely seem to have been touched, and a collector of the type of Perkins or Scott might find as rich a fauna as these two found respectively in Hawaii and Seychelles. We suggest to the New York Zoological Society that all speculation as to the origin of the Galapagos fauna is vain in the absence of such an intensive study, and that the outcome of their reconnaissance should be a determined attack directed to this end, before the islands are altered still more by the animals man has introduced. This, we conceive, is what the progress of biological science demands from them.

J. Stanley Gardiner.

Animate Nature.

Animal Studies. By James A. Todd. (Foundations of Nature Study Series.) Pp. 135. (Edinburgh: A. Baxendine and Sons, 1924.) 2*s.* 6*d.* net.

With the best intentions in the world it is impossible to give an adequate summary of the animal kingdom in ninety small pages of print, and the author of this little book has attempted too much in the space allowed him. The book has been published mainly to obviate the so-called waste of time involved in note-taking by students. The author's own lectures must of necessity have been fuller than the very imperfect summary given here would indicate, and judicious notes taken by the students themselves at the time would have been infinitely more useful to them. The book is an example of that tendency to excessive spoonfeeding which is so much to be deprecated in modern educational methods, and can serve no really useful purpose. The illustrations are poor and in many cases unrecognisable. We have not detected many actual errors of fact, but Asellus is not found on the seashore, and the generic name of the blow-fly is incorrectly given.

Vivarium and Aquarium Keeping for Amateurs: a Practical Guide to the Hobby. By A. E. Hodge. Pp. 128+6 plates. (London: H. F. and G. Witherby, 1924.) 5*s.* net.

As the author justly remarks, the construction of vivaria and aquaria is mainly a matter of common sense and ingenuity, based on an adequate knowledge of the habits of the animals to be kept in them. Mr. Hodge is, therefore, content to lay down a few guiding principles and to devote the main part of the book to those special requirements of food and environment peculiar to individual species, the knowledge of which is only gained by experience. In this respect the book is most valuable, and the author's hints and practical advice will save the beginner many an anxious hour and many an unnecessary loss. Attention is confined to reptiles, batrachians, and fishes, with special reference to the British species, and only to those which require no heating apparatus. The book makes a timely appearance in view of the opening of the new aquarium at the London Zoo, and should do much to popularise a fascinating hobby.

Deer-stalking in Scotland. By Alexander Inkson McConnochie. Pp. 208+8 plates. (London: H. F. and G. Witherby, 1924.) 10*s.* 6*d.* net.

The author has here collected together a series of memories and adventures among the deer forests of Scotland, contributed by enthusiastic devotees of the sport of deer-stalking, and a goodly number of stalking yarns wherewith to beguile the autumn evenings after a good day on the moors. The book is essentially written for the sportsman rather than the naturalist. The chronicle is well and racily told, and will appeal to all those who have experienced the thrill of the hunt. The Duke of Atholl contributes a preface, in which he touches briefly on the much-disputed question of the economics of deer forests.

Thermionic Valves and Radio Communication.

The Thermionic Valve and its Developments in Radio-Telegraphy and Telephony. By Prof. J. A. Fleming. Second edition, fully revised. Pp. xiii+438. (London: The Wireless Press, Ltd.; New York: Wireless Press, Inc., 1924.) 15*s.*

So rapid have been the advances made in radiotelegraphy and radiotelephony that the author has found it necessary to rewrite much of the first edition of this useful book. The invention of the two-electrode thermionic valve by Prof. Fleming in 1904 made an entirely new departure in the radio art. The subsequent development of the hard three-electrode valve marks an equally important advance. With the exception of the crystal detector, all other types of detector for electric waves have now been made antiquated. As a generator of electric oscillations the valve has come to the front. As a relay or repeater in telephony also it is being very widely used. The author has added a new chapter on thermionic relays. A telephone line filter is described, and a clear account is given of carrier wave telephony applied to ordinary telephone lines. Speech has been transmitted perfectly from the Atlantic to the Pacific Ocean. It first passed by radio thirty miles over the sea, then 4000 miles overland by wire, and finally it passed thirty miles over sea again by radio. All the transmissions were effected by thermionic valves, no human agency being employed.

Thermionic Tubes in Radio Telegraphy and Telephony. By John Scott-Taggart. Second edition. Pp. xxiv+470. (London: The Wireless Press, Ltd.; New York: Wireless Press, Inc., 1924.) 15*s.*

The thermionic valve has come into almost universal use for radio-communication. This volume describes the development of this valve and gives many of its applications. The author has considerable practical experience of valves and has made a judicious selection from the leading papers and the more important patents on the subject. If he errs at all, it is in making the book too comprehensive and going too much into detail. A beginner reading this book almost wants some one to point out what to read and what to omit, at least, on a first reading. Very properly the author begins by describing the phenomena in terms of modern theory. But we are afraid that our imagination fails to grasp what is meant by saying that there are about 10^{22} free electrons in a cubic centimetre of cold metal. Current is taken as flowing from points of high negative potential to points of low negative potential. Modern theory certainly explains very satisfactorily the working of the three-electrode thermionic valve. We can recommend this book to serious students of the subject.

Wireless Possibilities. By Prof. A. M. Low. Pp. 77. (London: Kegan Paul and Co., Ltd., 1924.) 2*s.* 6*d.* net.

It is useful occasionally to try to unravel the future. This is usually left to poets. The author of this little book, however, encouraged doubtless by the marvellous linking up of the whole world by radio-communication, has ventured to indicate some of the lines along which future developments will probably take place. Incidentally the reader learns many useful scientific facts. Radio television has almost been realised. Why not methods of preventing local thunderstorms and of improving the growth of wheat or of young animals? Radio waves may affect our health. Why should we not try to render this effect beneficial? The days of the outside aerial are limited. The study of radio-active materials may in one day produce the cold-emitter valve. It is difficult to believe that we are not on the eve of great scientific developments.

Forthcoming Books of Science.

Agriculture, Forestry, and Horticulture.

Ernest Benn, Ltd.—Varieties of Cultivated Oats, H. Hunter; Agricultural Progress: The Year Book of the Agricultural Education Association, 1925; "The Fruit Grower" Directory and Handbook, 1925; Cut Flowers for Market, F. J. Fletcher. *A. and C. Black, Ltd.*—Gardens of South Africa, Dorothea Fairbridge, with 16 page illustrations in colour from pictures by Elizabeth Drake and others. *Cambridge University Press.*—Farm Accounts, C. S. Orwin, new edition. *Central News Agency, Ltd.* (*Johannesburg*).—Cotton in South Africa, W. H. Scherffius and J. du P. Oosthuizen (S.A. Agricultural Series, Vol. III.). *Chapman and Hall, Ltd.*—Principles of Dairying, Judkins. *Hutchinson and Co.*—The Culture of Bulbs, Bulbous Plants, and Tubers Made Plain, Sir J. L. Cotter, Bart. *Longmans and Co.*—My Garden Book, J. Weathers; Every-day Life on an Old Highland Farm, 1769–1782, I. F. Grant, with a Preface by Prof. W. R. Scott. *G. Routledge and Sons, Ltd.*—Practical Forestry, from a Workman's Point of View, A. C. Drummie.

Anthropology and Archæology.

D. Appleton and Co.—Human Origins: A Manual of Prehistory, Dr. G. G. MacCurdy, 2 vols. *Cambridge University Press.*—The Races of Man and their Distribution, Dr. A. C. Haddon; The Social and Political Systems of Central Polynesia, R. W. Williamson, 3 vols.; The Origin of the English Nation, Prof. H. M. Chadwick, reprint; The Medieval Village, G. G. Coulton. *John Lane, the Bodley Head, Ltd.*—Our Prehistoric Forerunners, C. E. Vulliamy. *Longmans and Co.*—Great Peoples of the Ancient World, Dorothy M. Vaughan. *Macmillan and Co., Ltd.*—The Belief in Immortality and the Worship of the Dead, Sir J. G. Frazer, Vol III.: The Belief among the Micronesians; Ritual and Belief in Morocco, Dr. E. Westermarck, 2 vols.; Leaves from "The Golden Bough," culled by Lady Frazer; Men and Thought in Ancient India, Prof. Radhakumud Mookerji. *Methuen and Co., Ltd.*—Primitive Law, E. S. Hartland; Primitive Labour, L. H. Dudley Buxton; Folk-lore Studies: Ancient and Modern, Prof. W. Halliday. *G. Routledge and Sons, Ltd.*—Social Organisation, Dr. W. H. R. Rivers, edited by W. J. Perry; The Earth before History, E. Perrier; Prehistoric Man, J. de Morgan; A Thousand Years of the Tartars, Prof. E. H. Parker; The Threshold of the Pacific, Dr. C E. Fox, edited by Prof. G. Elliot Smith; London Life in the XVIIIth Century, M. Dorothy George; Language: a Linguistic Introduction to History, Prof. J Vendryes: A Geographical Introduction to History, Prof. L. Febvre. (History of Civilisation.) *Seeley, Service and Co., Ltd.*—Arabs in Tent and Town, A. Goodrich-Freer (Mrs. H. H. Spoer); In the Nicobar Islands, G. Whitehead, with a Preface by Sir R. C. Temple, Bart.; Pygmies and Bushmen of the Kalahari, S. S. Dornan.

Biology.

D. Appleton and Co.—Evolution, V. Kellogg; Race Hygiene and Heredity, Dr. H. W. Siemens, translated by Dr. L. F. Barker; The Criminal as a Human Being, G. S. Dougherty; Fishes, Dr. D. S. Jordan, new edition.

Edward Arnold and Co.—Huia Onslow: a Memoir, Muriel Onslow; Unscientific Essays, Prof. F. Wood Jones *J. W. Arrowsmith (London) Ltd.*—The Natural History of Selborne, Gilbert White: new edition edited and illustrated by R. Kearton. *G. Bell and Sons, Ltd.*—Sanctuaries for Birds and How to Make them, H. J. Massingham. *A. and C. Black, Ltd.*—The Open Book of Nature, Rev. C. A. Hall, new edition. *Cambridge University Press.*—British Waders, E. C. Arnold. *Constable and Co., Ltd.*—Red Deer Stalking in New Zealand, T. E. Donne. *Epworth Press.*—The Story of British Annelids (Oligochæta), Rev. H. Friend. *W. Heffer and Sons, Ltd. (Cambridge).*—Studies in Ampullaria, Rev. E. G. Alderson (to be issued by subscription). *Hutchinson and Co.*—Natural History of British Butterflies, F. W. Frohawk, with a Preface by Lord Rothschild; Dwellers of the Sea and Shore, W. Crowder. *J. B. Lippincott Co.*—Birds in their Relation to Man, C. M. Weed and N. Dearborn; Chemical Dynamics of Life Phenomena, O. Meyerhof (Monographs on Experimental Biology). *Longmans and Co.*—A History of the Earth from Star Dust to Man, Hilda Finnemore; Researches on Fungi, Prof. A. H. Reginald Buller, Vol. III.: An Introduction to the Study of Recent Corals, Prof. S. J. Hickson; Plant Forms and their Evolution in South Africa, Prof. J. W. Bews. *Macmillan and Co., Ltd.*—A Class-Book of Botany, E. Stenhouse. *McGraw-Hill Publishing Co., Ltd*—Regeneration, Loeb. *Methuen and Co., Ltd.*—The Study of Living Things: Prolegomena to a Functional Biology, Dr. E. S. Russell; A General Text-book of Entomology, including the Anatomy, Physiology, Development, and Classification of Insects, Dr. A. D. Imms. *L. Reeve and Co., Ltd.*—Illustrations of the British Flora: a series of 1321 Wood Engravings with Dissections of British Plants, drawn by W. H. Fitch, with additions by W. G. Smith and others, forming an Illustrated Companion to Bentham's Handbook of the British Flora and other Floras, new edition; The Flora of the Malay Peninsula, H. N. Ridley, 5 vols. Vol. IV.: Monocotyledones; Vol. V.: Monocotyledones (concluded), Gymnospermæ, Indices. *Sheldon Press.*—Chats on British Mammals, Ungulata, Carnivora, and Insectivora, Dr. J. J. Simpson.

Chemistry and Chemical Industry.

D. Appleton and Co.—The Story of Early Chemistry, Prof. J. M. Stillman. *Edward Arnold and Co*—Corrosion, U. R. Evans; The Principles of Applied Electro-chemistry, Prof. A. J. Allmand, new edition; Outlines of Organic Chemistry, E. J. Holmyard; The Chemistry of Bread-making, J. Grant, new edition. *Ernest Benn, Ltd.*—The *Chemical Age* Chemical Dictionary. Vol. I.: Chemical Terms; Vol. II.: Organic Substances; Vol. III.: Inorganic Substances; Chemistry and Atomic Structure, Dr. J. D. Main Smith; Classical Papers on Colloid Chemistry, edited by E. Hatschek; Cotton Cellulose: Its Chemistry and Technology, A. J. Hall; Synthetic Organic Compounds, Dr. S. P. Schotz; The Industrial Applications of Coal Tar Products, H. M. Bunbury and A. Davidson; Coal Tar Intermediates, A. Davidson; The Manufacture of Ammonium Products, P. Parrish; The Chemistry of Drugs, N. Evers, The Chemistry, Manufacture, and Uses of Aluminium, W. A. C. Newman; A Handbook of Ceramic Manufacture, Dr. H. N. White; The Chemistry of Essential Oils, H. Finnemore; The Dictionary of Intermediates; The Chemistry and Manufacture of Pigments and Paints, C. A. Klein, 2 vols.; Varnish Thinners, N. Heaton; Cellulose Varnishes, F. Sproxton; The Problems of Paint and Varnish Films, Dr. H. H. Morgan; The Analysis of Pigments, Paints, and Varnishes, Dr. J. J. Fox and T. H. Bowles; Blacks and Pitches, H. McK. Langton; The Chemistry of Drying Oils, Dr. R. S. Morrell and H. R. Wood; Resins, Natural and Synthetic, T. H. Barry and Dr. R. S. Morrell (Monographs on the Chemistry of the Oil and Colour Industries); The Dust Hazard in Industry, Dr. W. E. Gibbs; The Technology of Water, A. A. Pollitt; Distillation Principles, C. Elliott; Distillation in Practice, C. Elliott; Grading and Screening of Materials, J. E. Lister; Mechanical Mixing Machinery, L. Carpenter; Modern Muffle Furnaces, Dr. C. M. Walter; Mechanical Roasting Furnaces, W. Wyld; Organisation of Production, J. W. Curtis; Agitating and Kneading Machinery, H. Seymour; Grinding and Crushing Machinery, H. Seymour; Acid Reaction Chambers, P. Parrish. (Chemical Engineering Library.) *Chapman and Hall, Ltd.*—Principles of Fractional Distillation: being a translation of Hausbrand's "Die Wirkungsweise der Rektifizier und Distillier Apparate," Dr. E. H. Tripp, Aniline and its Derivatives, P. H. Groggins. *J. and A. Churchill.*—Elementary Qualitative, and Volumetric Analysis, Prof. W. Caldwell; Fourneau's Preparation of Organic Medicaments, translated by W. A. Silvester, Sutton's Volumetric Analysis, new edition by W. L. Sutton and A. E. Johnson; Thresh's Examination of Water and Water Supplies, new edition. *W. Heffer and Sons, Ltd. (Cambridge).*—Practical Physical and Colloid Chemistry for Students of Biology and Medicine, Prof L. Michaelis, translated by T. R. Parsons; Practical Chemistry by Micro-methods, Prof. P. C. Grey; Fundamentals of Bio-chemistry in relation to Human Physiology, T. R. Parsons, new edition. *Longmans and Co.*—Physical Chemistry for Students of Medicine, Prof. A. Findlay. *McGraw-Hill Publishing Co., Ltd.*—Elementary Qualitative Analysis, Reedy. *Methuen and Co., Ltd.*—Colloid and Capillary Chemistry, Prof. H. Freundlich, translated by Dr. H. S. Hatfield; The Elements of Colloidal Chemistry, Prof. H. Freundlich, translated by Prof. G. Barger; A Manual of Colloid Chemistry, Prof. Wo. Ostwald, with the collaboration of W. P. Walski and Dr. A. Kuhr, translated by Dr. J. N. Kugelmass and T. K. Cleveland; A First Chemistry for Schools, W. H. Hewitt and S. T. E. Dark; Examples in Chemistry, Dr. W. W. Myddleton; Chemical Symbols, Formulæ, and Calculations, A. W. Wellings. *A. J. Rayment.*—Refrigeration in the Chemical Industry, G. W. Daniels. *G. Routledge and Sons, Ltd.*—The Theory of Quantitative Analysis, and its Practical Application, Prof. H. Bassett.

Engineering.

Edward Arnold and Co.—The Enlarged Callendar Steam Tables (Fahrenheit Units), Prof. H. L. Callendar; The Measurement of Fluid Velocity and Pressure, the late J. R. Pannell, edited by R. A. Frazer. *Ernest Benn, Ltd.*—The *Electrician* Series of Specialists' Data Books, edited by E. B. Wedmore, D. V. Onslow, and J. H. Rayner, in three self-contained volumes. Vol. I.: Lighting, Traction, and Power Distribution; Vol. II.: Manufacture, Design, and Laboratory Work; Vol. III.: Telegraph, Telephone, and Radio Engineering; Small Electric Generating Sets, W. Wilson; Rotary Convertors, F. P. Whitaker; Electric Cables, C. Beaver; Motive Power and the Modern Steam Turbines, Sir Charles Parsons and R. Dawson; Electrical Measuring Instruments, Dr. C. V. Drysdale and A. C. Jolley. Part 2: Induction Instruments, Supply Meters and Auxiliary Apparatus; Radio—Past, Present, and Future, A. H. Morse; Wireless Telegraphy and Telephony, Prof. W. H. Eccles, new edition; Self-instruction for Students in Gas Engineering—Elementary, new edition; The *Gas World* Year Book, 1925; Aerial Rope-ways and Telpherage, H. Blyth; Recent Progress in Engineering Production, C. M. Linley; Haulage and Winding, H. M. Morgans. *Chapman and Hall, Ltd.*—Motor Ships, A. C. Hardy; Tables of Compound Steel Girders, F. B. Mason; Mechanical Design of Overhead Electrical Transmission Lines, E. T. Painton; History of the Telephone, F. G. C. Baldwin; Storage Batteries, Vinal. *Constable and Co, Ltd.*—Diesel Engine Design, H. F. P. Purday, new edition; High Tension Transmission Lines, E. V. Pannell. *Crosby Lockwood and Son.*—Carburation: In Theory and Practice: a Manual of Reference for Designers, Automobile Engineers, and Owners, R. W. A. Brewer, new edition; Railway Points and Crossings: a Survey of Problems encountered in Actual Practice, and their Solution, A. A. G. Dobson; Combustion in the Gas Producer and the Blast Furnace: a Theory, Dr. A. Korevaar. *Longmans and Co.*—Mechanics of Textile Machinery, W. A. Hanton; The Book of the Locomotive, G. G. Jackson. *McGraw-Hill Publishing Co., Ltd.*—Electric Wiring, Schuhler; Structural Engineering, Swain, 2 parts; Conduit Troubles and Testing, Croft; Magnets, Underhill; Industrial Electricity, Dawes, Part 1: Electrical Machinery and Control Diagrams, Croft; Substation Operation, Kurtz; Electrical Drafting and Design, Bishop.

Sir Isaac Pitman and Sons, Ltd.—Electrical Technology, H. Cotton (Engineering Degree Series); Drawing Office Practice, H. P. Ward; Handbook of Clutches, R. Waring-Brown; Electric Lighting and Power Distribution, Vol. II. Revised by C. H. Yeaman; Low Temperature Distillation, S. North; Railway Electrification, H. F. Trewman; Theory and Practice of Alternating Currents, A. T. Dover; The Induction Motor, Dr. H. Vickers; Machine Design, G. W. Bird (Engineering Degree Series). *A. J. Rayment.*—Heavy Oil-Engines Handbook, G. Porter; Specifications: a Handbook for Builders, W. E. Davis; Sanitary Science, Applied to Buildings and Public Works, H. Adams, Compressed Air Engineer's Handbook; Salesmanship for Engineers; Pulverised Fuel Handbook; Concrete Builder's Handbook, The Metal Worker's Handbook. *S. Rentell and Co., Ltd.*—Practical Electrician's Pocket Book, 1925. *Scott, Greenwood and Son.*—Concrete Making Machinery, W N. Twelvetrees. *Wireless Press, Ltd*—Wireless Valve Transmitters: The Design and Operation of Small Power Transmitters, W. James.

Geography and Travel.

Edward Arnold and Co—From China to Hkamti Long, Capt. F. Kingdon Ward. *J. W. Arrowsmith (London) Ltd.*—On the Earthquake Line: Central American Wanderings, Morley Roberts; The Shifting Sands of Algeria, Cherry Kearton; The Vast Sudan, Major A. Radclyffe Dugmore.—*Cambridge University Press.*—Ross and Cromarty, Prof. W. J. Watson (Cambridge County Handbooks and Geographies). *Hutchinson and Co.*—The Vanished Cities of Arabia, Mrs. Steuart Erskine. *Macmillan and Co, Ltd.*—Normandy; Northern Italy (The Blue Guides); The Continent of Europe, Prof. L. W. Lyde, new edition, Geography of Australasia and New Zealand, B. C. Wallis. *Methuen and Co., Ltd.*—North America: an Historical, Economic, and Regional Geography, L. R. Jones and Dr. P. W. Bryan. *G. Routledge and Sons, Ltd.*—The Eastern Road: Travels in China and Japan, L. Dudley Buxton. *Sheldon Press.*—Rivers and Lakes: The Story of their Development, M. A. C. Hinton; Richard Hakluyt, Dr. Foster Watson. *H. F. and G. Witherby.*—In the High Himalayas: Sport and Travel in the Rhotang and Baralacha, with some Notes on the Natural History of that area, H. Whistler; The High Grass Trail. Trekking and Shooting for Sustenance in Dense Bush across British Central Africa, F. Savile; Beneath African Glaciers· The Humours, Tragedies and Demands of an East African Government Station as experienced by an Official's Wife, with some personal views on Native Life and Customs, Anne Dundas; On Fresh Tracks in the Belgian Congo: From the Uganda Border to the mouth of the Congo, H. Norden.

Geology, Mineralogy, and Mining.

Ernest Benn, Ltd.—Mine Organisation and Accounts, H. F. Marriott; The Working of Stratified Mineral Deposits, H. F. Bulman. *Cambridge University Press.*—A History of British Earthquakes, Dr. C. Davison. *McGraw-Hill Publishing Co., Ltd.*—Mineral Industry, Vol. 32. *Sir Isaac Pitman and Sons, Ltd.*—Mining Educator, edited by J. Roberts (in fortnightly parts).

Mathematical and Physical Sciences.

Edward Arnold and Co.—Life of John William Strutt, Third Baron Rayleigh, O.M., by his son, R. J. Strutt, Fourth Baron Rayleigh; Isotopes, Dr. F. W. Aston, new edition; Ions, Electrons, and Ionising Radiations, Prof. J. A. Crowther, new edition. *Blackie and Sons, Ltd.*—Optical Measuring Instruments: their Construction, Theory, and Use, Dr. L. C. Martin (Blackie's Applied Physics Series). *Cambridge University Press.*—Relativity and Common Sense, F. M. Denton; Sound, S. E. Brown (Section 6 of Part 1 (Physics) of "Experimental Science"); Experimental Statics, A. P. McMullen and E. W. E. Kempson; Elementary Mathematical Problem Papers, Rev. E. M Radford; Graduated Problem Papers, R. M. Wright. *Cassell and Co., Ltd.*—Evenings with the Stars, Mary Proctor *Chatto and Windus*—The Three Orders of Perspective, G. Barne. *J. and A. Churchill.*—Elementary Physics, G. Stead. *Constable and Co., Ltd.*—Introduction to the Theory of Physics, Prof. A. Haas, translated by T. Verschoyle, 2 vols. *Longmans and Co.*—The Military Uses of Astronomy, Major F. C. Molesworth, with a Foreword by General Sir W. R. Birdwood, Bart.; Elements of Mechanism, Profs. F. S. Carey and J. Proudman; Applied Elasticity, Dr. J. Prescott. *Macmillan and Co., Ltd*—The Theory of Relativity, Dr. L. Silberstein, new edition; Everyday Physics, H. E. Hadley; A Shorter School Geometry, H. S. Hall and F. H. Stevens. Part II. and complete. *McGraw-Hill Publishing Co., Ltd.*—Elements of Applied Physics, Smith. *Methuen and Co, Ltd.*—The Theory of the Brownian Movement, Prof. A Einstein, translated by A. D. Cowper; A Survey of Physics, Prof. Max Planck, translated by R. Jones and D. H. Williams; Physico-Chemical Evolution, Prof. E. Guye, translated by J. R. Clarke; Modern Magnetics, Prof. F. Auerbach, translated by H. C. Booth; Space and Time: an Experimental Physicist's Conception of these Ideas and their Modification, Prof. C. Benedicks, translated by J. Harden, with an Introduction by Sir Oliver Lodge, Conformal Representation, Dr L. Lewent, translated by R. Jones and W. H. Williams, X-Rays, M. de Broglie, translated by J. R. Clarke. *Sir Isaac Pitman and Sons, Ltd.*—Primary Physical Science, W. R. Bower

Medical Science.

George Allen and Unwin, Ltd.—A Manual of Contraceptive Technique for Medical Practitioners, N. Haire; Rejuvenation: the work of Steinach, Voronoff, and others, N. Haire; The Internal Secretions· for the Use of Students and Physicians, Dr. A. Weil, translation by Dr. J. Gutman, Rejuvenation by Grafting, S. Voronoff. *Edward Arnold and Co.*—Text-book of Pathology, Prof. R. Muir; Text-book of Physiology, Prof. H. E. Roaf. *Baillière, Tindall and Cox.*—Errors of Accommodation, and Refraction of the Eye: a Handbook for Students, Dr. E. Clarke, new edition. *Ernest Benn, Ltd*—The Clinical Chemistry of Blood, O. L. V. de Wesselow; General Surgery for Dental Students, W. E. Tanner. *A. and C. Black, Ltd.*—Practical Pathology, Morbid Anatomy, and Post-mortem Technique, Dr. J. Miller, new edition. *Cassell and Co., Ltd.*—How is your Heart? Dr. S. Calvin Smith. *J. and A. Churchill*—Refraction of the Eye, including Physiological Optics, Dr. C. B. Goulden; Greenish's Materia Medica, new edition; Recent Advances in Medicine: Clinical, Laboratory, and Therapeutic, Drs. G. E. Beaumont and E. C. Dodds. *Constable and Co., Ltd.*—Modern Views on Gastric Disease, Dr. H. Maclean; The Ductless Glands in Medicine, Dr. L. Brown; Our Present Views on the Feeding of Infants, Dr. Patterson and Dr. Forest-Smith; Modern Methods in the Diagnosis and Treatment of Renal Disease, Dr. H. Maclean, new edition. *W. Heffer and Sons, Ltd. (Cambridge).*—The Internal Secretions of the Sex Glands: the Problem of the Puberty Gland, Prof A. Lipschutz, with a Preface by Dr. F. H. A. Marshall. *William Heinemann (Medical Books), Ltd.*—Essays and Addresses on Digestive and Nervous Diseases and on Addison's Anæmia and Asthma, Dr. A. F. Hurst; The Theory and Practice of the Steinach Operation, Dr. P. Schmidt, with an Introduction to the English edition by Dr. J. Abraham; Chronic Epidemic Encephalitis, Dr. A. Wimmer, with Preface by Sir Frederick Mott; Pneumonia: its Pathology, Diagnosis, Prognosis, and Treatment, the late Dr. R. M Leslie, edited and partly revised by Dr. J. B. Alexander; Ultra-violet Rays in the Treatment and Cure of Disease, P. Hall. *H. K. Lewis and Co., Ltd.*—An Introduction to Forensic Medicine: for Medical Students and Practitioners, H. A. Burridge; The Nervous Patient, Dr. M. Culpin, with a Chapter on "The Major Psychoses" by Dr. Stanford Read, and on "Eye Symptoms" by W. S. Inman. *J. B. Lippincott Co.*—The Diagnosis of Children's Diseases· with Special Attention to Diseases of Infancy, Prof. E. Feer, translated by Dr. C. A. Scherer; Fractures and Dislocations: Treatment and After-care, Dr. P. D. Wilson and Dr. W. A. Cochrane; Roentgen Diagnosis and Therapy, Dr. A. C. Christie; The Crippled Hand and Arm, Dr. C. Beck. *E. and S. Livingstone (Edinburgh)*—An X-ray Atlas of the Normal and Abnormal Structures of the Body, A. McKendrick and C. R. Whittaker. *Longmans and Co.*—Principles of General Physiology, Sir W. M. Bayliss, new edition; Digitalis, Prof. A. R. Cushny.

Metallurgy.

Ernest Benn, Ltd.—Modern Blast Furnace Practice, F. Clements; Chemistry of the Non-ferrous Metals, C. C. Smith. *Jonathan Cape, Ltd.*—Lead: the Precious Metal, O. C. Harn. *Chapman and Hall, Ltd.*—Stainless Iron and Steel, J. H. G. Monypenny. *Longmans and Co.*—Iron and Steel in the Industrial Revolution, T. S. Ashton. *McGraw-Hill Publishing Co., Ltd.*—Detailing and Fabricating Structural Steel, Dencer. *Scott, Greenwood and Son.*—Fatigue of Metals, H. Gough.

Meteorology.

Epworth Press.—The Atmosphere and its Story, E. Frith.

Miscellaneous.

D. Appleton and Co.—Contributions of Science to Religion, edited by Dr. S. Mathews; Elements of Business Statistics, Prof. R. Riegel. *G. Bell and Sons, Ltd.*—Concerning the Nature of Things: Royal Institution Lectures, Sir William Bragg; Chats on Science, E. E. Slosson. *Cambridge University Press.*—The Purpose of Education, St. G. L. Fox Pitt, new edition, The Cambridge Modern History Atlas, new edition; A Dictionary of the Hausa Language, Rev. Dr. C. H. Robinson, new edition; Catalogue of Scientific Papers, 1884–1900, Compiled by the Royal Society of London, Vol. XIX. *Cassell and Co., Ltd.*—The Story of Broadcasting, A. R. Burrows. *J. and A. Churchill.*—Pregl's Quantitative Organic Microanalysis, translated by Dr. E. Fyleman: Lucas and Stevens' Book of Receipts, new edition. *Macmillan and Co., Ltd.*—The Economics of Welfare, Prof. A. C. Pigou, new edition; Palgrave's Dictionary of Political Economy, new edition, edited by H. Higgs. Vols. I. and III.; Economic Papers, Prof. F. Y. Edgeworth, with Introductions to the various sections by the author, 3 vols.; The Science of Public Finance, G. Findlay Shirras; The State Theory of Money, Prof. Knapp, translated by J. Bonar. *McGraw-Hill Publishing Co., Ltd.*—Text-book of Salesmanship, Russell; Scientific Management since Taylor, Hunt; Business Writing, Hall; Printing and Typography for Beginners, Levitas; Real Estate Handbook, Snyder; Graphic Statistics in Management, Smith; Bookkeeping and Elementary Accounting, Sweeney. *Methuen and Co., Ltd.*—A History of the University of Oxford, Sir C. E. Mallet, 3 vols. Vol. I.: The Medieval University and the Colleges founded in the Middle Ages. Vol. II.: Oxford in the Sixteenth and Seventeenth Centuries; Science and Religion, Prof. J. A. Thomson. *Charles Scribner's Sons.*—A Popular History of American Invention, edited by Kaempffert, with contributions by F. Decker, T. C. Martin, H. D. Hubbard, La Verne W. Spring, and others. 2 vols. *Seeley, Service and Co, Ltd.*—Electrical Amusements and Experiments, C. R. Gibson (Scientific Amusement Series); Photography and its Mysteries, C. R. Gibson (Science for Children Series); The Wonders of Mining, A. Williams (Wonder Library). *H. F. and G. Witherby.*—Hold Hard! Hounds, Please: A Discourse on the Foxhound in Field, Covert and Kennel, with Hunting Yarns, Character Sketches from Life and some notes on Breeding and Kennel Treatment, "Yoi-Over"; A Romance of the Rostrum: Being the Business Life of Henry Stevens and the History of the well-known King Street Sale Rooms, E. G. Allingham.

Philosophy and Psychology.

D. Appleton and Co.—Readings in Philosophy, Dr. A. E. Avey; The Field of Psychology: A Survey of Experience, Individual, Social, and Genetic, Prof. M. Bentley; The Normal Mind, Prof. W. H. Burnham; The Principles of Reasoning, Prof. D. S. Robinson. *A. and C. Black, Ltd.*—Kant on the Moral Life: an Exposition of Kant's Grundlegung, Prof. J. W. Scott; Psychology and the Sciences, edited by Dr. W. Brown, with contributions by Dr. J. S. Haldane, Dr. L. P. Jacks, Dr. M. W. Keatinge, Dr. R. R. Marett, T. W. Mitchell, Rev. A. L. J. Rawlinson, and Dr. F. C. S. Schiller. *Cambridge University Press.*—The Religion of the Manichees, Rev. Prof. F. C. Burkitt. *Jonathan Cape, Ltd.*—Hearing, Prof. R. M. Ogden; The Soul of Woman, Dr Gina Lombroso, translated. *Chatto and Windus.*—Space, Time, Motion, Prof. A. V. Vasiliev, translated by H. M. Lucas and C. P. Sanger, with an Introduction by Bertrand Russell. *Constable and Co, Ltd.*—The Psychological Theory of Value, G. B. Dibblee. *J. B. Lippincott Co*—Dynamic Psychology, T. V. Moore; Psychology from the Stand-point of a Behaviourist, J. B. Watson, new edition. *Macmillan and Co., Ltd*—Bernard Bosanquet: a Short Account of his Life, Helen Bosanquet. *Methuen and Co., Ltd.*—Experimental Psychology, Mary Collins and M. E. Bickersteth, Industrial Psychology and the Production of Wealth, H. D. Harrison; Child-lore: a Study in Folk-lore and Psychology, Mrs. S. Herbert. *Mills and Boon, Ltd.*—The Mind and How to Manage It, "Psychologist." *Open Court Company.*—Popular Lectures, L. Boltzmann; Geometry, R. Descartes, translated; Ausdehnungslehre, H. Grassmann, translated, A Memoir of the Life and Work of Philip E. B. Jourdain; Precritical Essays on Space and Time, Immanuel Kant; Civilisation and Mechanics, E. Mach; Knowledge and Error, E. Mach; Principles of the Theory of Heat, E. Mach; The Aims of Scientific Method, and other Philosophical Essays, Prof. T. P. Nunn; Essay on Non-Euclidean Geometry, G. Reimann; American and English Pluralist Philosophers, J. Wahl; Relation of Space and Time to Experience, N. Weiner; Vegetable Staticks, S. Hales, edited, with notes, by Sir Francis Darwin; Arithmetica Infinitorum, J. Wallis, translated and edited by J. M. Child; Motive Power of Heat, Carnot, edited by A. E. Heath; De Morgan's Works—Formal Logic, edited by Prof. A. E. Taylor. (The "Open Court" Classics of Science and Philosophy.) *Kegan Paul and Co., Ltd.*—Medicine, Magic, and Religion, Dr. W. H. R Rivers; The Nature of Intelligence: a Biological Interpretation of Mind, Dr. L. L. Thurstone; The Growth of the Mind: an Introduction to Child Psychology, Prof. K. Koffka, translated by Prof. R. M. Ogden; The Mentality of Apes, with an Appendix on the Psychology of Chimpanzees, Prof. W. Koehler, translated by Ella Winter; Psyche: The Cult of Souls and the Belief in Immortality among the Greeks, E. Rohde, translated by W. B. Hillis; Telepathy and Clairvoyance, R. Tischner, translated by W. D. Hutchinson; The Psychology of Religious Mysticism, Prof. J. H. Leuba; The Psychology of a Musical Prodigy, Prof. G. Revesz; Physique and Character, E. Kretschmer, translated by J. W. H. Sprott; Psychology and Ethnology, Dr. W. H. R. Rivers, Introduction by Prof. G Elliot Smith (International Library of Psychology); Kant's Treatment of Causality, Dr. A. C. Ewing; The Divine Law of Human Being, F. C. Constable; The Unadjusted Girl: a Criminal Science Monograph, W. I. Thomas; A Neglected Complex, and Its Relation to Freudian Psychology, W. R. Bousfield; Fallacies of Sex, P. Bousfield; Human Psychology as seen through the Dream, J. Turner.

Technology.

Edward Arnold and Co.—Antiques: their Restoration and Preservation, A. Lucas, *Ernest Benn, Ltd.*—The Conversion of Coal into Oils, Prof. F. Fischer, translated by Dr. E. Lessing; Industrial Gaseous Firing, W. N. Booth; Modern Coal Washing Practice, R. C. R. Minikin; The Scientific Promotion of Gas Sales, A. Coe, Practical Polishing and Staining, A. Parkhouse, new edition. *Cassell and Co., Ltd.*—Practical Upholstery Illustrated, C. S. Taylor; Motor-car Overhaul and Adjustment; Practical Leather Working; Wood Turning made Easy; Electrical Toys and Tricks, A. F. Collins; Loud-speaker Crystal Sets: How to make and Manage them. *Chapman and Hall, Ltd.*—Seasoning and Preservation of Timber, E. G. Blake; Essentials of Printing, F. S. Henry. *Constable and Co., Ltd.*—Pattern Making, M. C. Wilson; Pressure Gauges, Indicators, Thermometers, Pyrometers, J. Smith; Moulding and other Foundry Work, W. Bell; Gas and Oil Engine Running and Maintenance; Diesel Engine Running and Maintenance; Plumbing; Boiler Making; Electrical Workshop Recipes. *McGraw-Hill Publishing Co., Ltd.*—Properties and Uses of Wood, Koehler; The History of Bleaching, S. H. Higgins. *Sir Isaac Pitman and Sons, Ltd.*—Cotton Spinner's Pocket Book. *G. Routledge and Sons, Ltd.*—Practical Cabinet-making, H. G. Phillips. *Scott, Greenwood and Son.*—Carpets and Rugs, the late Prof. R. Beaumont.

Printed in Great Britain by R. & R. Clark, Limited, *Edinburgh*

SATURDAY, SEPTEMBER 20, 1924.

CONTENTS.

Editorial and Publishing Offices :
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.

Editorial communications should be addressed to the Editor.
Advertisements and business letters to the Publishers.

Telephone Number: GERRARD 8830.
Telegraphic Address: PHUSIS, WESTRAND, LONDON

Coal and Electric Power.

A STRONG plea for an improved utilisation of coal as a source of motive power is made in the second part of the volume "Coal and Power,"[1] the Report of an Enquiry presided over by the Rt. Hon. D. Lloyd George, the first part of which has been referred to already in these columns (August 23, p. 265). The Committee of Liberal Members of Parliament and other persons responsible for the Report has examined the present system of generation and distribution of electrical power in Great Britain, and has come to the conclusion that "immense saving and improvement can be effected in this respect."

The waste that occurs in the methods now in vogue in connexion with the utilisation of coal for industrial and other purposes is a subject which has been under close study on the part of engineers in Great Britain, as well as in other parts of the world, for several decades past; the measures by which this waste can to some extent be reduced have been repeatedly indicated by them. The subjects of coal conservation, home-grown food, and the better utilisation of our labour were, for example, chosen for the theme of the able and brilliant presidential address which Mr. S. Z. de Ferranti delivered on November 10, 1910, to the Institution of Electrical Engineers (see Jour. I.E.E., 1911, vol. 46). In this address, Mr. de Ferranti directed attention to many of the matters which are dealt with, under the title "Power," in the Report before us, and pointed clearly to the direction in which a reduction in the cost of production of electrical energy should be sought, indicating, at the same time, that the increased use of electricity was a matter that depended almost entirely on the cheapness at which it could be sold. In view of the slow progress which has been made in Great Britain in extending the use of electricity for industrial and domestic purposes, and for the reason that important benefits would follow on its extended use, it is all to the good that the Committee should, in its Report, have again directed attention to the advantages to be gained from the electrification of our industries and our homes.

The Committee points out that the reorganisation of the coal-mining industry which it is advocating, though a matter of the utmost importance, is only part of a programme which aims at the rejuvenation of British industry, and it frankly admits that it is seeking the solution to the problem of how to increase wages without at the same time increasing the cost of manufactured commodities. The Committee shows that there is nothing incompatible in aiming at attaining

[1] Pp. xiv + 139 + 16 plates. (London: Hodder and Stoughton, Ltd., 1924.) 1*s.* net.

both these ends simultaneously. "A survey of the chief industrial countries of the world reveals," says the Report, "the extremely significant fact that those people are best paid and most prosperous that make most use of the resources of science"; the reason for this state of things being found in the fact that the average level of earnings must depend on production, and production increases as the use of power per head of the population increases.

Attention is directed in the Report to the circumstance that Great Britain became, in the first half of the nineteenth century, pre-eminent in the world as the greatest of all manufacturing countries because it was the first country in the world to realise the potential powers of steam. British engineers led all other countries; and, in the matter of railways, our system was the pioneer one. In the early days of steam engineering it was Great Britain that other countries copied: but now, in the matter of electrical development, the rôles are reversed. The Committee alludes to the activities of other countries which are our competitors in the world's markets, and mentions the fact that most of them are pressing ahead with schemes of electrification. "When one surveys the modern industrial world from this angle, it almost seems," says the Report, "as though we alone are content to mark time." An authoritative estimate indicates that the increase in the production of electricity in Great Britain during the period 1913 to 1922 was 130 per cent., an increase which is less than that achieved in any of the countries of our chief competitors. Again, whilst the development in Great Britain has hitherto been almost entirely in the direction of adding units to existing small and scattered local supply stations operating independently each of the others, foreign countries have in recent times been concentrating on larger power supplies on modern methods linked up and co-ordinated by main transmission lines.

A brief examination is made in the Report of the electrical development in certain foreign countries. This examination discloses the fact that the United States of America leads the way, its output having quadrupled since 1912; Chicago alone produces five times as much electricity as the whole of the North-East Coast plant, the largest scheme of electrification in England. The output in France had, up to April 1924, increased more than three and a half times as compared with 1913; the network of transmission lines is now so widespread that the ordinary hydro-electric stations are linked up with the glacier stations, and both with the thermic stations, and all with the consumers in the industrial region. It is expected that, by 1927, sixty-nine per cent. of the population will have electricity available. Germany, though harassed by many adverse factors, has made a greater advance in the direction of electrical development along coal-saving lines than has Great Britain; its output has more than doubled since 1913. Lignite, a mineral of very poor qualities, is now supplying nearly one-half of the electrical power of Germany.

In Holland, production more than doubled between 1913 and 1918. A scheme is now in hand which aims at covering the country with a network of high-tension transmission lines with the view of supplying Dutch industries with cheap power; on its completion, the output of the country will be increased 76-fold. In the case of Italy, special State encouragement is being given to the development of hydro-electric generation; in the year November 1922-November 1923 no fewer than 134 concessions for water-power schemes were granted by the Government. A great scheme intended for the development of the resources of Calabria was begun in 1923. In Czecho-Slovakia an Electricity Act was passed in 1919 providing for financial aid from the State for electrical development. Great activity on the development of hydro-electric schemes has prevailed in Canada in recent years. Although the population of the Dominion is only about one-sixth that of the United Kingdom, Canada will by the end of 1924 be getting from hydro-electric plant alone more power than the engine capacity for the whole of the iron, steel, engineering, shipbuilding, and textile trades in Great Britain. As regards the supply of cheap electric power through hydro-electric plants, Great Britain cannot compare favourably with some other countries. It is, however, becoming more evident every year that water-power is not an indispensable adjunct to many electro-chemical and electro-thermal enterprises, and that other sources of power sometimes possess decided advantages.

The reason for Britain's comparative failure in the field of electrical development is traceable, the Report rightly points out, to the state of our legislation, the effect of which has been gravely to handicap the genius of our engineers; "the power companies established under the Power Acts have never been given an adequate chance to develop. They have suffered from the fact that already there had been established in all industrial centres and in all our great cities, local and municipal power supply undertakings which were organised on a purely local basis." This circumstance precluded free competition between the power companies and the existing authorities. The measures taken to remedy this unfortunate situation are mentioned. As a first step, a Coal Conservation Committee was established in 1917; it made a Report of the utmost importance (Cmd. 9084). The matter was afterwards considered by another Committee, under the chairmanship of

Sir A. Williamson, which made certain specific recommendations.

The Government of the day then took action and passed the Electricity (Supply) Act, 1919 (9 and 10 Geo. V. c. 100), in which was incorporated many of the recommendations alluded to, and under its provisions have been brought into existence the Electricity Commissioners; in this body has been vested the general control over the generation and distribution of electricity in the United Kingdom. The Government did not secure in the Act of 1919 all the powers in relation to electricity supply it was seeking; the Bill was strongly opposed in the House of Lords. Later, the Government sought and obtained further powers under the Electricity (Supply) Act, 1922 (12 and 13 Geo. V. c. 46), which, though it improved matters to some extent, did not effect, and was not designed to effect, the original intention, namely, that of replacing many small stations by a few great power stations, with resultant economies in coal and in money.

Dealing with the place of electricity in modern life, the essential requirement, it is pointed out, is cheap power; so far, this result has not been secured in Great Britain on any notable scale. As an illustration, the case of Lancashire is quoted; this county is, from the technical point of view, the most favourable area in England for the generation and distribution of electricity cheaply, yet, at the date the Coal Conservation Committee of 1917 made its Report, the cost per unit was in Lancashire nearly three times that paid in the North-East Coast district of England. Examples of a similar disparity in the cost of energy are to be found in other parts of the country, and are due to the same cause; whereas in Lancashire a number of corporations are supplying energy in circumscribed areas, in the North-East Coast district a super-power station is transmitting energy in an area of suitable dimensions through well-placed main transmission lines. The need for the elimination of waste, the importance of securing an increase in the use of electrical power and the financial and other advantages likely to accrue to the community from the removal of the smoke evil, the saving of by-products and a revival of rural industries, are all duly emphasised in the Report.

The Committee makes allusion to the very conservative policy which has been pursued by British railway companies in the matter of the electrification of their systems, and expresses the hope that in view of the fact that the financial and technical advantages of electric over other forms of traction are being clearly demonstrated in foreign countries, our railway directors will reconsider their policy in this matter, and further, that in the event of a national scheme of electric supply being undertaken, the railways will give it the advantage of their co-operation. "Railway electrification would do much," says the Report, "to assure the economic and technical success of electrical production on a national scale"; in this view many eminent engineers concur. The Committee also points out that there are many recent processes, *i.e.* (1) the fixation of atmospheric nitrogen, (2) electric smelting, (3) the recovery of dyes, which are only possible economically in a country well equipped not only with electrical plant, but with *modern* electrical plant.

The unemployment problem also receives attention in the Report. The Committee attributes the failure in Great Britain to utilise the great unemployed labour force which has been available for construction purposes since the War partly to the limitation of the powers of the Electricity Commissioners. "We believe that it would have paid the State," says the Report, "to have expended large sums in the development of our resources by the provision of State credits, or the loan of public money at low rates of interest, for by so doing the internal economy of the country would have been improved and non-productive expenditure reduced."

In view of the present situation, the Committee is impressed with the necessity that exists for steps to be taken immediately to remedy the backwardness of Great Britain in electrical development. It recognises that the Electricity Commissioners have since their creation rendered most valuable services, but feels that this body is seriously handicapped owing to the insufficiency of its powers, and to some extent by the vested interests of the local undertakings, which, in the nature of things, are not and cannot be "as efficient as a national system developed in accordance with the most recent practice and supplying electricity in bulk from super-power stations." For these reasons, the Committee recommends that the powers of the Electricity Commissioners should be enlarged; this body could thus be placed in a position effectively to remove the obstacles which now block the way to electrical development in Great Britain.

It is mainly in two directions that the development of our great power-producing organisations is now being hindered: (1) by the existence of a number of small and inefficient local supply bodies; and (2) by reason of the magnitude of the undertaking and the uncertainty of financial success under existing conditions. To overcome the first of these difficulties, the Committee would like to see the Electricity Commissioners endowed with compulsory powers of acquisition, co-ordination, and regulation. To overcome the second of these difficulties, the Commissioners should, it is suggested, be granted full powers to employ every practicable means for encouraging and helping

electrical undertakers, public and private, who are prepared to establish generating stations of suitable capacity and type. Finally, the Report lays particular stress on the need for the Commissioners being authorised to empower electricity undertakers "to acquire compulsorily and at reasonable prices all land, rights of way, rights relating to water, and all ancillary rights, which may be necessary for the adequate execution of a national scheme."

The additional powers which it is recommended should be conferred on the Electricity Commissioners are undoubtedly large; however, few persons, if any, who are familiar with the electricity requirements of Great Britain are likely to cavil at the proposals made by the Committee. The situation which has to be dealt with is a very complicated one, and the reforms indicated, which undoubtedly are all urgently required, can only be brought about expeditiously by vesting in the Commissioners exceptional powers.

An idea as to how complicated the present situation is may be gathered from a perusal of the recitals of the "Order made by the Electricity Commissioners under Sec. 7 of the Electricity (Supply) Act, 1919, constituting the London and Home Counties Electricity District and establishing and incorporating the London and Home Counties Joint Electricity Authority" (H.M.S.O.). This Order was made on July 17 last after an investigation of many days' duration, and has been submitted to the Minister of Transport for confirmation; the interests and rights of the London County Council, the City Corporation, and 14 Power companies are involved, and it has been necessary to promote two Bills in the present session of Parliament in connexion with the Order. Situations which are equally, if not more, complicated exist in those parts of the country which have yet to be dealt with by the Commissioners.

It may well be asked, Why is it that the United States of America lead in the matter of electrical development? The answer to this question is to be found in the presidential address which Mr. W. H. Patchell delivered on March 21, 1924, to the Institution of Mechanical Engineers: this exceptional development, he tells us, is the direct outcome of the skill and zeal of those who handle the sales department of the American electricity supply undertakings. It will be evident, then, that if results similar to those obtaining in the United States of America are to be achieved in Great Britain, not only must additional powers be given to the Electricity Commissioners, but those responsible for the conduct of our electrical undertakings must also take a broad view of the commercial side of the business and adopt active measures for pushing the sale of their commodities.

Nature and Man in Tropical Africa.

Big Game and Pygmies: Experiences of a Naturalist in Central African Forests in Quest of the Okapi. By Cuthbert Christy. Pp. xxxi+325+56 plates. (London: Macmillan and Co., Ltd., 1924.) 21s. net.

DR. CHRISTY'S "Big Game and Pygmies," based as it is upon almost twenty-five years' continuous experience of tropical Africa, is a most interesting and valuable book. The "external aspects of organic nature" are not merely being modified by human interference in Africa; they are there being rapidly and almost completely transformed. The value of the observations so faithfully recorded in this volume will therefore steadily increase. When at last the varied face of Africa shall have been reduced to a dead level of cultivated monotony; when all its nobler animals and plants shall have been replaced by peaceful beasts of the farm and dull vegetation of economic importance, this will be one of the books that will enable our heirs to appreciate what sacrifices we made in the names of civilisation and commerce.

An admirable account of the great equatorial rain-forest is given by Dr. Christy. Stating that it must once have stretched as an unbroken belt completely across the continent, he describes its destruction at the hands of men. A good deal of the forest was destroyed before the advent of the whites; and to-day too, the barbarous methods of agriculture employed by the natives are responsible for a great deal. Strip after strip is cleared, by felling and by fire, along the forest margins. Ignorant of the art of maintaining its fertility, the natives soon exhaust the virgin richness of the forest soil and proceed to make further depredations upon the forest. The abandoned clearings are quickly overgrown by grass and bush; but upon their sun-baked and exhausted soil rain-forest never reappears. The forest once destroyed thus goes for ever; and with it must disappear many of its inhabitants. Not improbably much of that progressive desiccation of Africa, about which so much has been written from the days of Livingstone onwards, is to be regarded as a direct consequence of the destruction of the equatorial forest. That is a matter worthy of consideration, and it is possible that the conservation of the remnants of this great forest will loom as largely in African politics in a few years' time as reparations, for example, have done in those of Europe recently.

While native activity slowly but surely results in the replacement of one African type of life by another, white enterprise appears to be leading to the extirpation of the African biota. Enormous tracts of country are being cleared of the indigenous vegetation and replanted by exotic plants of economic importance.

For example, Dr. Christy foretells the time when South American Ceara rubber will replace the "profitless" bush and marginal forest and supply the world with india-rubber serviceable for all ordinary purposes at a penny a pound. From the selfish point of view of the dweller in remote temperate countries, that, no doubt, is good news; but from the point of view of a naturalist it is a deplorable prospect. A proportion of the native vegetable and animal inhabitants of Africa will doubtless succeed in adjusting themselves to the new conditions, but for a very large number, and among them the most interesting of the purely African forms of life, it spells extinction. Like the rain-forest, they are doomed if the commercial exploitation of the continent continues to proceed upon the present lines. So far as the larger mammalia are concerned, the process is hastened considerably, of course, by the rifles of ivory hunters and sportsmen. Dr. Christy says:

"As an indication of the amount of ivory that has come, and comes, out of the Congo annually, I may mention that I have seen lying in a trader's store at Boga about fifty fine tusks. . . . The trader informed me that the collection was the result of a month's buying from the natives. He also said that he received an average of one ton of ivory per month, about seventy-five or eighty fair-sized tusks, from his Kifuku branch store on the Ituri River south of Irunu. His was only one of many scores, perhaps hundreds, of similar trading and collecting stores, at which ivory was the chief cause of their existence."

In view of what we have permitted in our own African possessions, we have no right to point an accusing finger at that Belgian enterprise to which Dr. Christy pays a high tribute. But no scientific man can contemplate the slaughter on such a scale of slow-breeding animals like elephants without realising that it must result in complete extermination. The thought too that, in spite of this butchery, and notwithstanding the great wealth derived from ivory, the material at present existing in our museums is wholly insufficient to enable the zoologist to determine how many species or sub-species of the African elephant should be recognised, or to obtain a detailed knowledge of its soft anatomy and skeleton, does not allay that feeling of resentment which must arise in every scientific breast.

It must not be thought that Dr. Christy shares the despondence of the reviewer. On the contrary, he light-heartedly treats of things seen and deeds done; despondence comes only with reflection and at a distance. In this book, Dr. Christy, while primarily concerned with the Ituri forest and its inhabitants, gives us the fruit of experience gained while engaged in general scientific and medical research or upon hunting expeditions in many parts of tropical Africa. To him is due the credit of making one of the finest zoological collections ever brought together from any part of Africa. This collection was made for the Belgian Government, and is now housed in the museum at Tervueren. It is especially rich in mammals. Of these, the smaller species were worked out in the British Museum by Mr. Oldfield Thomas, and as a result our national collection has been greatly enriched by the joint labours of the collector in the field and the systematist at home.

The chapters upon the okapi, the African elephant, and the African buffalo are of especial interest. Dr. Christy's views upon the status of the various forms of buffalo, illustrated as they are by numerous photographs and some most excellent maps, will merit and receive the serious consideration of all mammalogists busied with the African fauna. Many interesting observations upon other mammals, such as the forest hog, chimpanzi, bongo, duikers, aardvarks, ant-eaters, small mammals, and upon other vertebrates and insects, are also recorded. Chapters dealing with the skinning and preservation of specimens and with matters relating to forest-hunting and armament will be found useful by those who contemplate collecting trips in Africa.

Lastly, but by no means least, Dr. Christy's accounts of the Ituri pygmies and other native races will make a strong appeal to all interested in anthropology and ethnography.

M. A. C. H.

The Study of Textile Fibres.

The Textile Fibers: their Physical, Microscopical, and Chemical Properties. By Dr. J. Merritt Matthews. Fourth edition, rewritten and enlarged. Pp. xviii + 1053. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1924.) 50s. net.

TEN years having elapsed since the appearance of the third edition of this well-known text-book on the properties of textile fibres, the author has, for the purposes of the present edition, been under the necessity of re-writing, re-arranging, and greatly enlarging the volume, which now runs to upwards of a thousand pages, with more than four hundred illustrations.

In order to estimate the degree of success which has attended the very considerable labours of the author, due regard must be paid to his assertion, in the preface to the present edition, that "the great majority of his readers are neither chemists nor scientists"; for it is to this majority that the appeal of the book is directed. These readers, presumably those engaged on the practical side of the textile industry, are given an admirable summary of information upon the properties and uses

of all the important textile hairs and fibres, which is marked by a praiseworthy attempt to incorporate the results of recent advances in textile research made both in Great Britain and on the Continent.

The magnitude of such an attempt will be fully appreciated by any one actively engaged in textile research, and, in the result, defects of arrangement and lack of balance in the treatment of the various portions of such an enormous subject as the textile fibres are only to be expected. For example, wool and silk are both treated in an adequate and well-balanced fashion which might well have served as a model for the treatment of the other important hairs and fibres. On the other hand, in spite of the importance of the linen industry and of the amount of recent work carried out, both in Great Britain and on the Continent, upon problems connected with the structure, retting, and mercerisation of flax fibres, linen is dismissed with a short chapter of twenty-two pages, while the relatively unimportant minor seed hairs have sixteen pages devoted to them.

Of the seven chapters assigned to the cotton hair, some are unnecessarily elaborate, while from others important omissions are numerous. Those on mercerised cotton and the chemical treatment of fabrics for water- and flame-proofing are almost complete enough to form part of a technical handbook on these processes. Moreover, in the former, descriptions are included of the processes of schreinering and emerising which have no connexion with the problem of mercerisation.

Turning to the omissions, no account of the microscopic structure of the cotton hair can be regarded as complete which does not adequately take into consideration the work of Balls and Denham. Yet the former receives scant attention, while the latter is almost ignored. Again, in the chapter on the chemical properties of cotton there is no mention of the results of recent important researches on the nitrogen content of the cotton hair, the determination of copper number and the absorption of methylene blue by cotton. From the summaries of the physical and physico-chemical properties of cotton, notable omissions are the results of recent work upon the lustre and regularity of yarns and the swelling of single cotton hairs in solutions of sodium hydroxide, all of which are problems of vital concern to the cotton industry and of fundamental importance in textile research.

The reasons for such omissions will be sympathetically appreciated by the research worker on textile problems. During the last five years, the whole appearance of the field of textile research has been altered, chiefly owing to the activities of the research associations of Great Britain, and one is driven to the conclusion that an adequate summary of the origin, properties, and employment in industry of cotton, linen, silk, wool, and artificial silk is now quite beyond the powers of a single author. Such a summary must not only be a record of progress in several wide fields, all of which are being actively explored in every direction, but must also, at the same time, remove from a position where it affects the views of those who are "neither chemists nor scientists," a large amount of pseudo-science which has established itself in the technical literature. For example, the problem of mildew in cotton goods is one of very great economic importance in the cotton industry. Yet, in Chapter xvii. (pp. 554-555) of the volume under review, the first portion of a section on the action of mildew in cotton, is not only quite inaccurate and unscientific, but is also substantially the same as has been transferred from one technical handbook to another since the appearance in 1879 of "The Sizing of Cotton Goods" by Wm. Thomson. The section is completed by the addition of recent work by Thaysen and Bunker (unacknowledged) on the application of the viscose swelling test to damaged cotton, and of Denham on the destruction of cotton hairs by micro-organisms. To the uninstructed all this work is of equivalent value.

The information on commercial varieties of cotton in Chapter xii. might have been more carefully checked. No account is given of contemporary progress and tendencies in the cultivation of cotton within the British Empire and in Egypt; nor is it now quite correct to state that "India is destroyed as a possible source of supply [of long staple cottons] for the English mills." Such cottons are now being successfully raised in the Punjáb and are rapidly bought up when available. Egyptian cotton is also dealt with in an inadequate manner. Hindi cotton is actually given as one of the principal varieties grown in Egypt, whereas it has long been known as a pestilential weed-cotton causing endless trouble in the cotton field, owing to the ease with which it crosses with cultivated varieties.

The chapters dealing with the properties and analysis of jute, ramie, hemp, and the minor vegetable fibres are particularly well done, and, with their illustrations, represent a great advance on previous works. Those upon the analysis of textile fibres, fabrics, and yarns, and the testing of textile fabrics are similarly worthy of praise; although a more systematic arrangement of the tests would have been possible and some discussion of their comparative values useful.

In a work of such importance, errors and misprints should be lacking. During perusal a number have been noticed, *e.g.* the length of individual cotton hairs on p. 339 is given as ranging from $1\frac{1}{2}$ to $1\frac{3}{4}$ inches; Nubari cotton is spelt Unbari (p. 389); Smyrna cotton is included as African (pp. 391 and 414); the diameter of

Sea Island cotton is given as $9 \cdot 65\mu$ (p. 414), whereas it should be at least 50 per cent. greater; the cross-sections of cotton hairs given in Fig. 201 are mostly unlike any ever seen by the reviewer, while the sections shown in Fig. 186, p. 414, are those of hairs which have only been partially mercerised. A misprint on p. 787 gives the diameter of ramie fibre as ranging from 9·04 mm. to 0·06 mm. Such minor defects might be eliminated from subsequent editions.

F. SUMMERS.

Some Applications of Psychology.

(1) *Applied Psychology.* By Prof. Bernard C. Ewer. Pp. xii+480. 10*s.* 6*d.* net.
(2) *How to Experiment in Education.* By Prof. William A. McCall. (Experimental Education Series.) Pp. xv+281. 12*s.* net.
(3) *Intelligence Measurement: a Psychological and Statistical Study based upon the Block-design Tests.* By Prof. S. C. Kohs. Pp. xii+312. 14*s.* net.
(4) *The Psychology of Algebra.* By Edward L. Thorndike, Margaret V. Cobb, Jacob S. Orleans, Percival M. Symonds, Elva Wald, and Ella Woodyard. Pp. xi+483. 12*s.* net.

(New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1923.)

EVERY man considers himself an expert on psychological matters and is ready and willing to give his opinions. "Psychological" is a word used and misused countless times to connote the human or popular side of any activity, until its scientific implication is often buried under a sea of colloquial generalisations. No other scientific worker suffers, to the same degree as does the psychologist, from the unsought-for popularity of his subject. The chemist does not see "Chemical Drama" staring at him from the posters of the daily papers, nor does the geologist find a complex geological hypothesis used as a subject of drawing-room conversation. Such general interest has been aroused in psychology that quacks and charlatans turn it to their financial advantage. Prof. Ewer is evidently smarting under these popular misrepresentations of the subject. Again and again in his "Applied Psychology" he harps on the need for caution in accepting psychological beliefs. "As in the case of many another development in the history of culture," he writes, "this one has been characterised by great enthusiasm, overweening confidence, and a somewhat uncritical evaluation of results. Gradually, however, we see the ebullient assurance giving way to a more cautious spirit of inquiry, the glittering but unsubstantial froth of superficial investigation disappearing, and a solid precipitate of valuable information settling."

(1) Prof. Ewer has set himself the difficult task of writing a book which shall pass between the Scylla of technicalities intelligible only to the expert and the Charybdis of popular over-simplification, and he has succeeded singularly well. The book is divided into four parts covering the main field of applied psychology: "Aims, Principles, and Methods," "Education and Everyday Life," "Mind and Health," and "Industry and Commerce." In the first more general portion, the author gives an introduction to the chief mental factors and the methods of their interpretation and control. The rest of the book is devoted to a description of their practical applications. This is fascinating reading and is of immediate use as well as of interest, for every one will find some advice applicable to himself. Prof. Ewer has not originated any great new schemes for training or curing the mind, but he gives a clear and impartial account of the main theories on these matters. He is fully alive to the dangers of the various applications of psychology and shows how to avoid their abuses as well as how to promote their beneficial effects.

Especially interesting are the chapters on "Intellectual Efficiency" and "Everyday Psycho-therapy." Here, as in all his work, Prof. Ewer keeps as close as possible to common experience. As he says: "Psychology often succeeds only in giving precise form to what wise persons have long known, or reasons for what they have always done; but it is none the less desirable to have such exactitude and rationality scientifically established." If every one was to read this book before airing his views on applied psychology, there would be much less inconsequent babbling.

(2) "How to Experiment in Education" is a book that will save young educational psychologists from many a weary hour and tedious mistake. Prof. McCall has succeeded in summarising his experience in such a manner as to hand it on to those starting in his field. It is almost as if one is buying experience with the 12*s.* that is the cost of the book. The author remembers his own difficulties when his professors trusted to his "genius to supply the missing half of research methodology." "There are excellent books," he writes, "dealing with the statistical manipulation of experimental data, but there is little help to be found on the methods of securing adequate and proper data to which to apply statistical procedure. Training is given and books exist only for the last step of a several step process. As a result, the final step often becomes little more than statistical doctoring for the ills in the data." Prof. McCall starts, therefore, at the very beginning and gives advice as to the selection and formulation of the experimental problem and the procedure of making a bibliography. His fundamental criteria for constructing a test are particularly helpful.

Psychological research has the peculiarity, compared to other scientific research, that its subjects are human and bear human relationships to the investigator and each other. Prof. McCall gives good advice as to the errors that arise from the faulty selection of the subjects, from the bias of the experimenter, and from other important causes. About half the book is devoted to comparing the three fundamental experimental methods: the one group method, the equivalent group method, and the rotation method The author discusses their various uses and gives a chapter to the computations for each method. A useful chapter is also given to "Casual Investigations," in which standardised methods of observation are suggested when experimentation is for some reason impracticable. The book concludes by discussing twenty-eight typical experimental problems, showing the best method to apply to each. The author has attempted to make his book particularly clear and concise by expressing all relationships by formulæ, but here perhaps he rather defeats his own ends, as the abbreviations used necessitate a three-page key.

(3) The position of intelligence tests is now thoroughly established, and it is acknowledged that they form a means of obtaining a quick and trustworthy measurement of an individual's general ability Until recently, most intelligence tests have had a linguistic bias, but it is now realised that some people can do themselves justice more adequately when dealing with things rather than with words. Several practical or "performance" tests have been standardised with varying degrees of success, and some were used in the giant investigation of testing the whole American Army. There is, however, a great need for additional trustworthy tests of this type. Dr. Kohs has limited his book "Intelligence Measurement" to a description of a series of block-design tests devised by him, which he has proved to give results corresponding closely to other criteria of intelligence. The tests consist of a series of coloured blocks which must be put together to make patterns of such varying degrees of difficulty that some can be passed by a five-year-old child and others are difficult for an adult The technique of standardising the tests is extremely well described, and the ninety tables of figures in the explanation should serve as a warning to those who believe that to devise an intelligence test it is only necessary to think of some questions and give them to a few children.

(4) Any teacher of algebra, whether he started this term or has had forty years of experience, will be stimulated by reading Prof. Thorndike's "Psychology of Algebra." Experimental proof is worth a lot of theorising, and this book is the outcome of large scale investigations on many aspects of the subject. Many of the topics are quite original, but the more familiar problems, such as the best order of presenting matter, and the optimum distribution of practice, are not neglected. An interesting study is made of the use of algebraical knowledge to science students. *Questionnaires* were sent to lecturers of the various physical and social sciences, and text-books were analysed to see the relative practical value of the different algebraic topics. But although such applications of the subject are studied, its intrinsic value is also realised—the appeal of "the love of thought for thought's sake by those who can play the game of thought well."

WINIFRED SPIELMAN.

The Cactus Family.

The Cactaceæ: Descriptions and Illustrations of Plants of the Cactus Family. By N. L. Britton and J N. Rose. Vol. 4. (Publication No. 248.) Pp. vii+318+37 plates. (Washington: Carnegie Institution, 1923.) 6.50 dollars.

THE issue of the fourth volume of "The Cactaceæ" brings this sumptuous monograph of the family to a conclusion. Previous volumes have been discussed in NATURE, vol. 107, p. 580, and vol. 111, p. 426.

Vol. iv. is carried out in the same excellent manner as the preceding volumes, and completes the account of the smaller and more popular species of this family. It deals with the remaining three subtribes, namely, the Coryphanthanæ, consisting of 14 genera, of which the principal is the familiar genus Mammillaria (herein renamed Neomammillaria); the Epiphyllanæ, consisting of 9 genera, which of all Cacti are probably the greatest favourites with horticulturists; and the Rhipsalidanæ, consisting of 8 genera. There is also an appendix and an index to the whole work. The volume is beautifully illustrated with 37 fine plates, most of them coloured, and 263 figures in the text. Full references are also given throughout the work to figures that have appeared in other books.

Altogether (including two new genera and 24 new species described in the appendix) this volume treats of 33 genera and 358 species, the largest genera being Neomammillaria, 150 species; Rhipsalis, 57 species; Coryphantha, 37 species; Epiphyllum, 16 species; and Thelocactus, 12 species; 14 genera are monotypic, and the others have only 2-8 species each. In the entire work, 124 genera and 1241 species are described and illustrated by 137 plates and 1119 figures; of these, a considerable number are described and figured as new.

About two-thirds of the species dealt with in the present volume belong to plants known in gardens under the generic names of Echinocactus and Mammillaria; the latter name, however, has now been

altered by the authors to Neomammillaria, because the name Mammillaria properly belongs to a genus of Algæ! It is unfortunate that previous monographers of Cacti had not long ago recognised this and changed the name in accordance with the rule of priority, for the name Mammillaria has become so firmly established in books and gardens for these Cactaceæ that it will be difficult to supplant it by the new name.

Another generic change of name, now rightly made, which ought to have been done long ago by previous monographers, is to retain the name Epiphyllum, which was first published in 1812, for those plants known in books and gardens under the name of Phyllocactus, which was not published until 1831. The plants known in books and gardens under the name of Epiphyllum belong to the genera Zygocactus and Schlumbergera.

Of the genera, 12 are published in this volume for the first time, and there are 3 others that have been published elsewhere since the issue of the first volume. Although some of the genera in this work will probably not be upheld by future workers, the authors have consistently followed their plan of utilising all vegetative and structural characters that differ in degree or nature for the formation of genera, with the result that the species having the same characters in common are associated together in a more complete manner than hitherto.

The authors deserve the hearty thanks of all lovers of Cacti for the admirable and efficient manner in which they have completed their task. In doing this they have fortunately been better equipped for it than any previous monographers of the group. For not only have the authors themselves visited some of the regions where these plants grow, and studied them under natural conditions, but they have also received great aid from many others interested in the group who reside in or have visited the various countries in which Cacti grow wild, and have contributed quantities of living material, photographs, and information appertaining to them, all of which has been utilised in constructing this fine monograph; the result being that, not only is it the first monograph of Cactaceæ that has been published in the English language, but is also one that is far in advance of the German works upon the subject that have hitherto held the field.

It cannot be expected that a work of this kind is without errors, but to the knowledge of the writer the authors have done their best to avoid them. The one thing wanting appears to be a series of plates clearly illustrating the distinctions between the various genera. Perhaps the authors may see their way to supply them as a supplement.

N. E. BROWN.

Our Bookshelf.

The Work of the Royal Engineers in the European War, 1914–1919. Work under the Director of Works (France). Part 1: Historical; Part 2: Technical; Part 3: Maps and Plates. (Published by the Secretary, Institution of Royal Engineers, Chatham.) Pp. viii + 279 + 6 maps + 81 plates. (Chatham: W. and J. Mackay and Co., Ltd., 1924.) 21*s*.

THIS volume from its very nature lacks some of the thrilling interest which characterised some of the earlier volumes of the series to which it belongs, owing to the fact that it deals with a struggle against difficulties carried out for the most part at a distance from the enemy. When enemy action upset the plans of the Director of Works it was, save in the case of the bombing of hospitals, power stations, or important bases, generally due to a change in the plans of the whole army, in which the Director of Works had become necessarily involved. The struggle outlined in this volume is one to meet the demands of constant expansion and development with inadequate resources of labour, personnel, and equipment. Granted the conditions, it is marvellous how much was achieved and, on the whole, how successfully new demands were met.

The volume under review contains six chapters outlining the changes in each year of the War, the developments characteristic of successive phases, followed by twenty-five chapters of a technical nature discussing the separate branches of work for which the Director of Works became responsible. It is well illustrated by maps of the lines of communication areas, and by numerous diagrams of camps, larger buildings, huts, machines, and plant of various types. Much useful information is given about such items as camp sanitation, disinfection, and protection against hostile aircraft. On the whole, the book is of the nature of a technical guide to the engineer officer who is concerned with the design of camps.

The human element is rather lacking in the book, though we may mention the consternation caused among the inhabitants of Rouen when it was discovered that the goats in the Halle des Blés, protected from inclement weather by shutting all doors and windows, needed ventilation, and when on the windows being opened the pent-in effluvium of the goats rushed out and spread about the neighbourhood. Another human touch is supplied by the provision that on the lines of communication all hospitals *must* be lit by electric light, ammunition, supply, and ordnance depots *should* be lit, and camps, remount depots, and veterinary hospitals *might* be lit, if a supply could be obtained locally at a reasonable cost.

Die Entfaltungsbewegungen der Pflanzen und deren teleologische Deutung. Ergänzungsband zur "Organographie der Pflanzen." Von Prof. Dr. K. Goebel. Zweite, neu bearbeitete Auflage. Pp. x + 565. (Jena: Gustav Fischer, 1924.) 20 marks.

THE work of Prof. Goebel, of the University of Munich, is known to all students interested in the morphology and physiology of plants. His "Organographie der Pflanzen" was translated into English

by Prof. (afterwards Sir) I. B. Balfour and published by the Clarendon Press, vol. i. in 1900, vol. ii. in 1905. Since these dates a new German edition has been appearing (1913–23), and to it there was added in 1920 a supplementary yet independent volume dealing with the movements of attached plant-organs. The first edition of this last volume was quickly exhausted, and a second, considerably enlarged, has now been issued.

Much of Prof. Goebel's work can be described as a synthesis of morphology and physiology, and the present work is no exception. Here, however, the author has set himself a definite problem, namely, to investigate the kinds and methods of movements shown by plant-organs, and especially to decide whether or not they are adaptational. The word "Entfaltungsbewegungen" would seem scarcely to cover all the contents of the book, for the stimulated movements of floral parts and of sensitive plants, and also "sleep-movements," are considered, in addition to movements connected with the unfolding, growth, and development of buds, leaves, and flowers. The various movements are fully described in the text, which is illustrated by 278 figures, more than half of which are reproductions from photographs.

The number and variety of species on which observations are recorded, and on many of which experiments were made, enable Prof. Goebel to put forward his views with some confidence, albeit he is not dogmatic. Throughout the work he is decidedly sceptical concerning the various teleological theories which have been proposed, largely under the influence of Darwinism, as explanations of the movements of plant-organs. Unavoidable reaction, not purposeful response, is suggested again and again. That the movements often are relatively advantageous is not to be denied, and it may be granted that Natural Selection would tend to eliminate any species which had developed decidedly disadvantageous movements, but the advantages or disadvantages are secondary, not the purpose of the movements the origin of which has been fortuitous. Goebel further emphasises the manifold ways in which the movements of plant-organs occur, and it seems possible that the usual classification is misleading and has itself suggested false teleological conclusions. At least, the extensive studies which have been published by Prof. Goebel indicate that generalisations based on limited, even if intensive, observations and experiments may often prove false. W. B. T.

Medical and Veterinary Entomology: a Textbook for Use in Schools and Colleges as well as a Handbook for the Use of Physicians, Veterinarians and Public Health Officials. By Prof. William B. Herms. Second edition, completely revised. Pp. xv+462. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1923.) 28*s.* net.

IN the second edition of this work the chief new features are the historical introduction, dealing with the development of medical entomology, and the additions to various chapters of material derived from the author's experience as a sanitary officer in the U.S. Army during the War. The external features used in classification and the life-history of the insects of medical and veterinary importance are considered, but internal anatomy is dealt with only in a few cases. Methods of control are carefully discussed, and references given in the most important cases to the original sources of the respective methods. The most detailed chapters are those devoted to lice, mosquitoes, house-flies, larvæ which produce myiasis, and ticks, and these are the chapters which will be most useful to the majority of readers. The accounts of other insects, *e.g.* fleas, are less satisfactory from the medical point of view; thus, although the characters of *Xenopsylla cheopis* are given there is no reference to *X. astia* or to *X. brasiliensis*—which the reader should be shown how to differentiate from *X. cheopis*, and the author is in error in regard to the structure labelled as hypopharynx in the figures of the fleas shown on p. 322. In the brief account of the life-history of *Dipylidium caninum* the work of Joyeux (1916) might have been referred to. The observations of Dr. and Mrs. Connal (1922) on the life-cycle of *Filaria* (*Loa*) *loa*, and the work of Christophers (1922) on the segments of mosquito larvæ, were perhaps published just too late to receive notice. In the description of Fig. 20 the term pupa (of the house-fly) should be replaced by puparium. Good drawings would have been more helpful to the reader than certain of the photographic illustrations provided, *e.g.* Figs. 91, 140, 141, 143, 152, 161, 168, 180, 210.

The book has no doubt been written with particular reference to the needs of medical and veterinary students and public health officials in the United States, but the greater part of the work has a general application to the conditions in warm climates elsewhere, and will be found useful by those who desire a concise account of the biology and methods of control of the insects which attack man and animals.

A Third Year Experimental Chemistry. By W. H. Crabb. Pp. viii+247. (London: Mills and Boon, Ltd., n.d.) 3*s.* 6*d.* net.

ON leaving the university and entering a secondary school to teach science, the young graduate quickly finds that he has much to learn, and as he progresses he realises more and more the folly of spoon-feeding his pupils on "academic" science. If he is keen and progressive, he will construct his own notes and piece together the scaffolding of a potential text-book; and in compiling such data he will gather valuable experience. Whether his work will be published or not depends upon many factors: ambition, the self-regarding instinct, inertia, modesty—and publishers.

The small work under review appears, rightly or wrongly, to have originated in some such manner as the above, and it will be very useful not only to the author, but also to other teachers, if they do not prefer their own notes. The author is evidently a clear and conscientious teacher, and the only adverse criticism to be offered is that he covers too much ground; with the exception of pupils who are specialising between 17 and 19 years of age, it is very doubtful if any ordinary school class could adequately assimilate more than half the contents of this book in a working school year, say, of 30 weeks; and probably only a small minority of pupils could tackle the work successfully after a two-years' course in elementary chemistry. To take one

lesson as an example. The sixth lesson, on diffusion and liquefaction of gases, comprises revision of experiments on these subjects, Graham's law, and practical applications; then some historical notes leading to a very sketchy notice, without diagrams, of liquefaction of gases by self-cooling; and lastly, as "topics for discussion," commercial liquefaction of gases, separation of oxygen and nitrogen from liquid air, uses of liquid air, methods of nitrogen-fixation, uses of liquid sulphur dioxide, chlorine and ammonia, carbon-dioxide "snow."

It is regrettable that attempts are still made in our schools to turn out ready-made chemists and physicists. Enlightened university teachers, and employers, do not want students of this kind; they want youths with acute and alert minds, having a sound knowledge of elementary principles and a keen desire for more.

Arabische Alchemisten. 1: Chālid ibn Jazīd ibn Mu'āwija. Von Julius Ruska. (Heidelberger Akten der von-Portheim-Stiftung, Heft 6.) Pp. 56. (Heidelberg: Carl Winter's Universitätsbuchhandlung, 1924.) 3 marks.

THIS scholarly dissertation upon Khalid ibn Yazid will receive a hearty welcome from all those who are interested in the history of chemistry. It must serve as a foundation for all future work upon Khalid, who is one of the most attractive of early Muslim chemists. Much that is legendary has been associated with him from a very remote period, and this apocryphal matter has naturally increased with the passage of time. Prof. Ruska carefully examines the principal sources for the life of Khalid and is able to show that they contain numerous inconsistencies and anachronisms. It is clear that none of them is entirely trustworthy, and the same may be said of the various books and poems in Arabic ascribed to Khalid, which are probably all spurious, even though they may contain authentic passages.

Prof. Ruska considers the Khalid-Morienus story at some length, and rejects it. He explains that in its earliest form the story makes Stephanus, contemporary with Herakleios (died 641), the teacher of Khalid (died 704), but suggests that when Muslim historical knowledge came to recognise that Stephanus had died before Khalid was born, a "pupil of Stephanus," Marianus or Morienus, was invented to act as a link between the two.

All the Latin works which pass under the name of Khalid or Morienus are declared by Ruska to be falsifications, particularly the "Liber Secretorum Artis compositus per Chalid filium Jaichi," and "Liber Trium Verborum Kalid Regis acutissimi." While this is probable enough, there is good reason to suppose that certain sections are of extremely ancient origin, as they may be found in Arabic in the "Kitāb al-Muktasab" (*c.* 1300), which goes back to "Ares" and Khalid for its authorities and is quite independent of the line of development passing through Rhazes and the Spanish Arabs.

One small error may be noted. On p. 49, Prof. Ruska attributes the "Rutbatu'l-Ḥakīm" to Maslama al-Majriti; it was in fact written about 100 years after Maslama's death. E. J. H.

The Fauna of British India, including Ceylon and Burma. Edited by Sir Arthur Shipley. *Birds.* Vol. 2. By E. C. Stuart Baker. Second edition. (Published under the authority of the Secretary of State for India in Council.) Pp. xxiii + 561 + 8 plates. (London: Taylor and Francis, 1924.) 30*s*.

THE second of the volumes on Indian birds undertaken by Mr. E. C. Stuart Baker, for the "Fauna of British India" series, is a worthy successor to the first. It contains a further instalment of the Passeres from the Cinclidæ (Dippers) to the Regulidæ (Gold-crests, etc.), and deals with 473 forms in a remarkably thorough manner. So far as is known, the vernacular names, nidification, and habits of each form, in addition to a complete systematic description, are given, and it is hoped that further observations under the first three headings will be recorded by Indian ornithologists. A noteworthy feature, as in the first volume, is the numerous coloured plates executed by the author himself, which are a credit to his artistic ability. A few eggs and nests might with advantage have been figured; a series of the former as a coloured plate would have made a fitting frontispiece, or a figure of the egg of each of the forms of which plates have been given might have been included in them. The absence of a full synonymy is again noticeable, but we learn with satisfaction that a sixth volume has been sanctioned which will contain a full synonymy of the forms dealt with in the previous volumes, and such addenda and corrigenda as are necessary.

The "Fauna of British India" series is, we believe, meant primarily to serve as complete handbooks on various groups for Indian collectors, and if this object is to be fulfilled in dealing with the birds, Mr. Baker would do well to take the opportunity of introducing a brief but complete introduction to Indian ornithology, containing notes on collecting, geographical distribution, and a map, with some account of the topography of the region insomuch as it concerns the Indian birds, in the sixth volume of his series. Mr. Baker's extensive knowledge of Indian field ornithology would make such an introduction most valuable. He is to be congratulated on producing a series which again makes it possible for those who have not his special knowledge to identify Indian birds correctly without wading through a mass of confusing synonymy.

C. DOVER.

Engineering Non-Ferrous Metals and Alloys. By Leslie Aitchison and William R. Barclay. (Oxford Technical Publications.) Pp. xx + 300. (London: Henry Frowde and Hodder and Stoughton, 1923.) 21*s.* net.

A TRUSTWORTHY account of the non-ferrous metals and alloys used for engineering purposes has been needed for some time, and Dr. Aitchison and Mr. Barclay have made an excellent effort to meet this need. Without entering into processes of manufacture, they discuss generally the properties of cast and wrought metals, and then describe in detail the several metals and alloys with their physical and mechanical properties, together with their principal uses. The statements of the authors are based on a wide practical experience, and may be regarded as authoritative. The section on the alloys of nickel will be found

particularly valuable. The metallographic side of the subject is less fully dealt with, and the photo-micrographs included do not constitute a representative series. The equilibrium diagrams might well have been omitted, as they bear no indication of the phases present, and the copper-aluminium diagram on p. 125 is impossible. The engineering reader would not derive any information from such diagrams, and the metallurgist would have to look elsewhere for an explanation of them. Mechanical testing is well and clearly described, but it is rather surprising that the now familiar Erichsen test is not included, it being greatly superior to the crude cupping test.

The book was completed too early to admit of the incorporation of the detailed report of the Alloys Research Committee on light aluminium alloys, but we may expect that this section will be expanded in a future edition. The same may be said of the die-casting alloys, as to which more information is now available than the authors have provided. It is certain that the book will be welcomed by engineers, and will be found useful by metallurgists.

The Literature of the Charadriiformes from 1894–1924: with a Classification of the Order, and Lists of the Genera, Species, and Sub-species. By Dr. George C. Low. Pp. xi + 220. (London: H. F. and G. Witherby, 1924.) 12*s.* 6*d.* net.

MUCH labour has obviously been expended in the preparation of this work of reference, and ornithologists must be correspondingly grateful to Dr. Low for his having placed so useful a tool in their hands. Its purpose is to supply a complete guide to the literature dealing with the Charadriiformes in the thirty years which have elapsed since the publication of volume xxiv. of "The British Museum Catalogue of Birds." The labours of other workers in this field will be greatly facilitated by the availability of these collected and classified references. A preliminary chapter discusses the classification and nomenclature of the group, and a second gives references to works of a general kind bearing on the subject. The rest of the book is devoted to references grouped under the names of the ninety-seven genera, in ten families, which Dr. Low admits to the order, and under each genus they are arranged chronologically. Some idea of the bulk of modern ornithological literature may be gathered from the fact that the references to this one order, admittedly an important and interesting group, fill about two hundred pages. Frequent use in actual work is the only true means of testing a book of this kind, but such checks as one can readily impose show that Dr. Low has performed his laborious task with the thoroughness and accuracy for which it called.

The Irish Setter: its History and Training. By Colonel J. K. Millner. Pp. 80 + 8 plates. (London: H. F. and G. Witherby, 1924.) 5*s.* net.

FROM the introduction we learn that this is the first book devoted solely to the Irish setter. It cannot, however, be regarded as more than a random collection of miscellaneous notes about the breed, and some of its most distinguished representatives, with an admirable chapter on training and a clear description of the points of the breed as approved by the Irish Red Setter Club. The origin of the Irish setter is apparently shrouded in oblivion. Beyond the suggestion that it has been derived from the red spaniel of the eighteenth century, used largely in hawking, and that its development dates from the beginning of the practice of shooting at flying birds in the last half of the same century, there is nothing really definite that is known, and no records are available which help to establish its history. A century ago there were apparently two distinct strains—red, and red and white, the latter predominating; but with the introduction of dog shows and the somewhat arbitrary requirements of fanciers, the red-and-white strain has largely disappeared. For show purposes only the merest traces of white on the head, chest, throat, and toes are allowable. Mr. S. W. Carlton contributes the introduction, and the book is illustrated by eight half-tone blocks of celebrated Irish setters, taken from the dogs themselves or from oil paintings.

Automatic Telephones. By F. A. Ellson. (Pitman's Technical Primers: Double volume.) Pp. xii + 215. (London: Sir Isaac Pitman and Sons, Ltd., 1924.) 5*s.* net.

AT first sight, automatic telephony appears to be a hopelessly complicated subject. Yet next year it will be necessary for all telephone subscribers to begin to get a working knowledge of it, as the British Post Office decided a year ago that automatic equipment is to be adopted in all important areas. We wonder whether in the future it will be well known that the "double dog" is knocked away until the wipers clear the banks and that during this process the stationary dog supports the weight of the shaft. In any case these terms will have to be included in technical dictionaries. The list of British standard terms made by the Engineering Standards Association and included in this volume is excellent. The advantages of the automatic system are the large savings that can be effected in the annual charges, the continuous day and night service, and the increased efficiency and accuracy. The disadvantages are the greater capital cost and maintenance charges, and the increased liability to faults at the subscribers' end. To the intelligent reader who wishes to understand the basic principles of the ordinary systems in use, we can recommend this book.

Anatolica. By Harry Charles Luke. Pp. xii + 210 + 40 plates. (London: Macmillan and Co., Ltd., 1924.) 16*s.* net.

IN this volume Mr. Luke again shows the knowledge and insight, together with the charm of style, that have made notable his previous volumes on the Near East. Among the flood of books on various parts of the eastern Mediterranean, it is rare to find one written with more authority or marked by greater conciseness and first-hand observation. It is entirely unpolitical, and consists of a series of short essays on various towns and districts, including Mount Athos, Salonika, Adrianople, Cyprus, the Holy Sepulchre, Petra, and the cities of Transcaucasia. The chapters on Cyprus are among the most vivid in the book, and recall the charm of the island. There is a quaint and sufficient map, and the illustrations are well chosen. The coloured frontispiece of Mount Ararat is excellent.

Letters to the Editor.

(*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*)

Specific and Latent Heats of Iron and Steel.

IN a letter on this subject published in NATURE of April 19 (vol. 113, p. 566) it was shown that if the *temperature* of the metal is raised continuously, the resulting expansion plotted in terms of time appears as a smooth curve exhibiting no peculiar features.[1]

If, on the other hand, *heat* is supplied in the same way, the variation of temperature, and therefore of expansion, is dependent on the specific heat of the

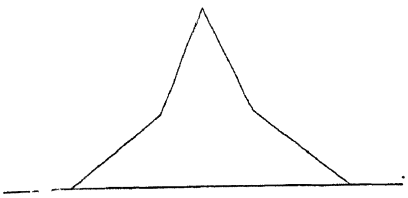


FIG. 1.—Diagrammatic representation of the extension of a material when heat is supplied and withdrawn at a constant rate, and the specific heat changes at a definite temperature.

material so that the rate of extension is (*cæteris paribus*) inversely as the specific heat.

If the rate at which heat is supplied is uniform, and if the only change in the metal at the critical temperature is in the specific heat, the curve representing the extension during a cycle of heating and cooling would be four straight lines as in Fig 1.

If, however, in the change from the low to the high temperature state, heat is rendered latent,[2] and provided that the change can be brought about by an infinitesimal excess of temperature above the critical value, the extension diagram will be of the form shown in Fig. 2.

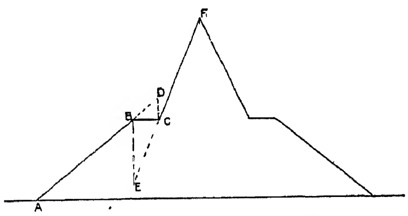


FIG. 2.—Conditions as in Fig 1, except that heat is rendered latent at the temperature of the change of specific heat The quantity of heat which becomes latent is equal to that which would raise the temperature sufficiently to cause the extensions CD or BE, according as the specific heat is taken as that belonging to the branch AB or CF.

The latent heat is that which would cause an expansion CD or BE, according as the specific heat is taken as having the low or high temperature value. When, as in my experiments, the variation of temperature in heating depends on the excess of heat supplied over that lost by radiation and convection, and in cooling on the difference of temperature between the heated wire and its surroundings, the straight lines in Figs. 1 and 2 become exponential curves, and the typical heating and cooling diagram is similar to that in Fig. 3.

The curved form of the junction between low and high temperature branches shows that the material is in an unstable condition at the critical temperature, and that to start the transition from one state to the other, the critical temperature must be exceeded in heating, or passed in the opposite direction in cooling, but that once started it proceeds in suitable conditions, with sufficient rapidity to reduce or raise the temperature of the wire, and thereby alter its length. To show these effects to advantage the diameter of the wire must be small enough to ensure that the difference of temperature between its surface and interior is small.

In the letter of April 19 previously alluded to, it was shown that the critical temperature was chiefly dependent on the proportion of carbon present in the metal, and it was suggested that in iron free from carbon the critical temperature might be found to be that corresponding to the intersection of the curves appropriate to the two specific heats. A reference was also made to the difficulty of obtaining iron containing no trace of carbon.

It seemed possible that such iron might be prepared by the "Thermit" process, and within the last few weeks I have experimented with wire drawn from an ingot of Thermit iron made at the Davy-Faraday Laboratory from pure materials. Lengths of this wire were heated with graphite for various periods in

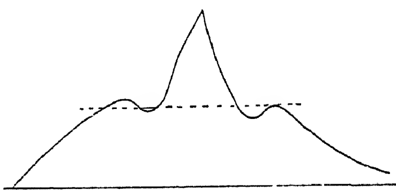


FIG. 3.—Diagram of the extension of the same material as that of Fig 2, when the net increment of heat is proportional to the excess of heat supplied above that lost in the same time by radiation, etc, and the loss of heat during cooling is proportional to the excess of the temperature of the material above its surroundings.

a combustion furnace, and the results of these trials are shown in Fig. 4.

It should be stated that the analysts find that the Thermit ingot contained something like 0·04 per cent. of carbon, and also that in a sample of electrolytic iron which the National Physical Laboratory were kind enough to supply the carbon percentage was 0·065.

In both cases the origin of the carbon is unknown. An examination of the curve in Fig. 4 shows that even a thirty minutes' heating in graphite causes a slight drop in the critical temperature and some change in the character of that part of the curve which indicates the extension while change of state is in progress.

These changes become more marked as the time of heating in graphite is prolonged, and when this reaches five hours, it is seen that there are two separate pauses at different temperatures in the heating curve and a double reheating during cooling.

All these peculiarities can be explained by supposing that the outer parts of the wire have been converted into a mild steel while the core remains comparatively pure iron: so that each part changes its state at the temperature appropriate to its carbon content.

The diagram Fig. 4, *a*, for the Thermit iron which has not been in contact with the graphite, shows a critical temperature slightly higher than that for the "Armco" iron referred to in my letter of April 19, but in other respects the results are identical; and in

[1] The actual coefficient of expansion of iron at first increases with the temperature, but diminishes as the melting-point is approached

[2] It is not unlikely that something of the same kind happens with any element which assumes an allotropic form on heating. If a small quantity of sulphur in the plastic state is "chawed," it soon resumes the crystalline form, and becomes gritty in the mouth, with a very sensible rise of temperature.

all the irons and steels I have used, the ratio of the low and high temperature specific heat is very nearly three to one.

In making steel by the cementation process on a commercial scale, I believe that iron bars exceeding 1 square inch in cross-section are heated in charcoal for a fortnight or more; and as the carbon probably passes into the metal by diffusion, it might be expected that in the case of an 0·02 in. diameter wire, saturation would be reached in a much shorter time. It would seem, however, judging from the lower of the critical temperature in diagram *f* of Fig. 4, that the five hours' heating has only produced a coating of very mild steel. The temperature at which cementation is carried out probably has an important effect on the rate of diffusion, and further experiments on this subject will be made with purer samples of iron, if such can be obtained. A. MALLOCK.

9 Baring Crescent, Exeter,
August 8.

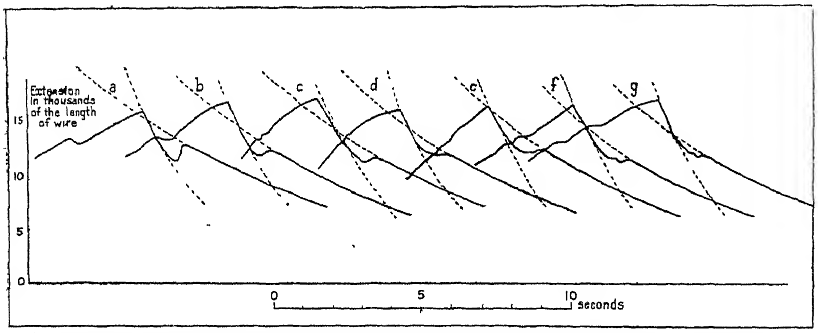


FIG. 4.—Tracings from diagrams of extensions during heating and cooling of wires drawn from "Thermit" iron, the wires being subsequently heated in graphite for the following time:

Diagram.	Minutes	Diagram.	Minutes.
a	0	*d*	180
b	30	*e*	250
c	60	*f*	320

The Rotatory Dispersion of Tartaric Acid.

EIGHTY-EIGHT years ago, Biot (*Comptes rendus*, 1836, 2, 542) showed that an *anomalous* rotatory dispersion could be produced by superposing two *normal* partial rotations of opposite sign and of unequal dispersion. This general theory of the origin of anomalous rotatory dispersion can be developed in two ways, according as it is supposed that a partial rotation of opposite sign is produced as the result of a chemical change in the optically-active molecule, or that the presence of two opposite partial rotations is one of its inherent physical properties. In the Bakerian lecture of 1921 (Phil. Trans., 1922, A, 222, pp. 249-308) we adopted, for the case of tartaric acid, the former explanation.[1] This was in harmony with the conceptions of Biot himself, since he attributed the variations in the rotatory power of this acid, *e.g.* in aqueous solutions, to chemical and not to physical causes; this point of view had also been stated in a very precise form by Arndtsen in 1858 (Ann. Chem. Phys., 1858, 54, p. 421). The same explanation has since been adopted by Astbury (Proc. Roy. Soc., 1923, A, 718, p. 527; NATURE, July 26, p. 122) as a sequel to his X-ray examination of the crystals, and by Longchambon (*Comptes rendus*, 1924, 178, p. 951) as a result of his study of their optical rotatory power. There is therefore a strong consensus of opinion amongst all those who have recently worked on the subject, that the anomalous rotatory dispersion of tartaric acid is related very intimately to its ability to undergo a reversible chemical change.

[1] The latter explanation has been adopted in the case of α'-bromocamphor.

Whilst the existence of this chemical change is admitted by all the workers named above, differences of opinion have arisen as to the exact nature of the change. Arndtsen adopted a perfectly general view as to the nature of the dextro- and lævo-rotatory components. In the same way, Longchambon (who identified the lævorotatory component with the ordinary crystals of the acid, and named the two components as α- and β-tartaric acid) offered no opinion as to the nature of β-tartaric acid In the Bakerian lecture, however, after a careful study of all the available evidence, we felt justified in concluding that the acid exists in two *isomeric* forms of opposite rotatory power. Astbury, on the other hand, postulated a reversible *polymeric* change, depending on "the tendency of the molecules to build themselves up into a lattice . . . even in dilute solutions." This view has been shown to be untenable in the case of ethyl tartrate (Lowry and Cutter, Journ. Chem. Soc., 1924, 125, pp. 1465-1470), where determinations of molecular weight can be made without the complications which would arise from electrolytic dissociation in the case of the free acid; and, although it is perfectly true that "the dextrorotatory system . . . predominates in dilute solutions" of the free acid in *water*, as required by Astbury's hypothesis, dilute solutions in *acetone* are *lævorotatory* (Austin and Park, 1924, unpublished observations). The progressive decomposition of "crystal molecules" into "chemical molecules," which was first put forward by Landolt in 1879 as an explanation of the mutarotation of the sugars, appears then to be equally invalid when brought forward again as an explanation of the anomalous rotatory dispersion of tartaric acid.

Astbury suggests that the individual molecules of tartaric acid contain an *intramolecular* spiral of four carbon atoms, which is *dextrorotatory*, whilst the crystals contain also an *intermolecular* spiral (formed by the juxtaposition of hydroxyl-groups in contiguous molecules) which is itself *lævorotatory*, but *is always accompanied by the fully developed dextrorotatory spiral*. Longchambon, on the other hand, supposes that whilst the *solutions* contain both a dextrorotatory and a lævorotatory component, these are individual chemical compounds and may therefore be separated from one another; the *crystals* therefore contain only the lævorotatory component (α-tartaric acid), the *dextrorotatory component* (β-*tartaric acid*) *having been eliminated completely during the process of crystallisation.*[2] These conflicting views can be tested by examining the relevant rotatory dispersions. In the case of aqueous solutions of tartaric acid, the rotatory dispersion can be represented by the equation:

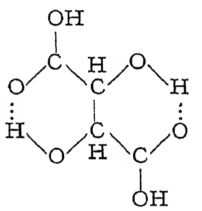
$$\alpha = k_1/(\lambda^2 - 0{\cdot}03) - k_2/(\lambda^2 - 0{\cdot}074).$$

The esters give similar equations but with rather smaller values for the second dispersion-constant. If the lævorotatory crystals of tartaric acid gave only the negative partial rotation of the aqueous solutions (as Longchambon supposes), the dispersion-ratio $\alpha_{4358}/\alpha_{5780}$ would be about 2·2, whereas *larger* values would be given if (as Astbury suggests) the negative rotation were masking a smaller positive term. The ratio 2·14 actually observed by Longchambon is almost identical with the value calculated from our equation, and therefore affords a conclusive

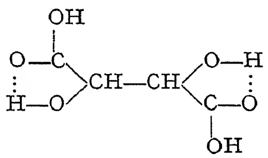
[2] Compare the complete separation of one of a pair of labile isomerides by crystallisation from solutions of α-glucose or of nitrocamphor.

vindication of his claim to have separated the lævo-rotatory component completely from the dextro-rotatory component which is formed from it in solution.

In his original paper, Astbury ascribed the anomalous dispersion of tartaric acid to "strings of molecules, connected together at the hydrogen junctions" of the hydroxyl-groups, which he represents as points of contact between contiguous molecules in the crystals, thus —OH HO.CO—. When it is realised that the X-ray analysis of organic compounds deals only with the orientation and spacing of *molecules*, and gives no information as to the positions of the individual *atoms*, it may be doubted whether there is any experimental foundation whatever for the wholly improbable view that the molecules of tartaric acid are held together *by the mutual attraction of two protons*. The idea that two hydroxyl-groups attract one another is indeed an old one; but since Bragg established the crystal-structure of ice, it has become evident that this action depends on a mutual attraction between the hydrogen of one molecule and the oxygen of another, a view that has recently been developed under the title of "Bivalent Hydrogen" by G. N. Lewis in America, and in Great Britain under the title of "The Co-ordination of Hydrogen" by one of the undersigned. Considerations of this kind have led us to conclude that the anomalous rotatory dispersion of tartaric acid and its esters probably depends on an interaction between the hydroxylic *hydrogen* and the carboxylic *oxygen*, giving rise to internal co-ordination-compounds such as



and



This conclusion is in harmony with the fact that the anomalous dispersion of tartaric acid persists in its esters, *in spite of the elimination of the carboxylic hydrogens*, which are essential to Astbury's hypothesis; it also agrees with the fact that all the anomalies disappear in the methylene ether (Austin and Carpenter, 1924) in which the hydroxylic hydrogens (but not the carboxylic hydrogens) have been eliminated.

If, as may be gathered from his letter in NATURE of July 26, Astbury is anxious to lay stress on the fact that the forces which produce anomalous rotatory dispersion in solutions of tartaric acid are identical with "the forces which bind the molecules into the crystalline structure," we should be in complete agreement with him, but we should regard these forces as depending on the simultaneous attraction of a proton for two oxygens, rather than of two protons for one another.

T. M. LOWRY.
P. C. AUSTIN.

Spiral and Structureless Nebulæ.

IN "Our Astronomical Column" of NATURE of August 2, reference is made to Prof. Perrine's letter on Prof. Lindemann's spiral nebula hypothesis which appeared in the *Observatory* for July. As Prof. Lindemann's hypothesis was based to some extent on photographic observations of my own, perhaps I may be permitted to make a few comments on the matter generally.

Prof. Perrine's criticisms on the supposed reflection of light from the Galaxy are not new, and are practically covered by my paper on Prof. Lindemann's theory which appeared in the Monthly Notices of the R.A.S. for May last year. The observational facts are entirely against this part of the hypothesis, and I think I am not misrepresenting Prof. Lindemann when I say that he does not attach so much importance to the *source* of reflection as to the probability of reflection being the cause of the colour distribution. There are considerably more grounds for assigning the source of reflection (if any) to the bright central nucleus of the spiral itself. I found, for example, that the curve of light distribution in the nucleus of the Andromeda nebula (N.G.C. 224) was a near approach to the curve $(x+1)^2y=\text{constant}$; and Hubble has recently derived much the same result for a series of bright amorphous ellipsoidal nebulæ of non-galactic type, which have been photographed with the 100-inch reflector at Mt. Wilson. This applies to the amorphous or uncondensed type of spiral nuclei, but it does not apply to the condensed type of spirals where numerous condensations appear and the nucleus is weakened by continued outflow of matter along the spiral arms. In the latter case the peak of the curve is considerably flattened, and the non-luminous matter at the periphery of the nebula is taken up into the condensations.

It may be inferred from this that reflection as a cause of illumination is a possibility in the amorphous type but is definitely ruled out in the condensed type. This has led me to doubt the validity of the photographic observations on which Prof. Lindemann's hypothesis was based. The photographs which Prof. Seares obtained at Mt. Wilson with the 60-inch reflector were comparative—one with an unscreened ordinary plate and the other with a yellow screen and an isochromatic plate. These showed quite definitely for the condensed type a stronger image of the nucleus in the isochromatic than in the ordinary plate compared with the outer regions of the spiral, the inference being that outer regions of the spirals are deficient in the longer wave-lengths. The same results were found in my photographs of the uncondensed type which were measured with a photo-micrometer, and were also carried down to the red region of the spectrum with panchromatic plates and suitable screens. Some photographs were also obtained of the nucleus of the Andromeda nebula with ordinary plates and a nickel oxide screen to cut out the visual part of the spectrum and transmit the ultra-violet. It is evident, however, that we are dealing with plates having contrast factors which differ with the wave-length, and the variation found may be owing to a combination between the range of spectrum and the plate employed.

This question has been dealt with at some length by Ross (*Astrophysical Journal*, vol. 52, p. 86), who finds that the variation of γ (the contrast factor) along the spectrum is greatest for panchromatic plates and least for orthochromatic plates. He points out also that the depth of image in the ultra-violet is not so great as in the longer wave-lengths, which penetrate further into the emulsion. At the same time, I should not wish to condemn the observations out of hand as untrustworthy, but rather I would advocate the repetition of them under more rigorous conditions, which is quite possible, and would give us definite information on this important point.

J. H. REYNOLDS.

Low Wood, Harborne,
August 14.

The Production of very Intense Magnetic Fields.

IN a letter to NATURE which appeared in the issue for April 19 last, I gave a brief outline of a method for producing very intense magnetic fields.

I have now made some measurements which show that magnetic fields of considerably greater intensity may be generated by this method than had appeared at first sight to be practicable. For example, in one test a magnetising solenoid wound with 25·5 turns per cm. was used, and the first peak value of the discharge current obtained when condensers of 700 micro-farads total capacity were used, charged to a pressure of 1850 volts, was found from the oscillograph record to be 12,500 amperes. *This means that an intensity of magnetic field of about* 400,000 *gauss was generated.*

By means of a modification of the apparatus which is now being effected, it is expected that an intensity of magnetic field of about 1,500,000 gauss will be obtained very shortly.

It is useful to examine what considerations govern

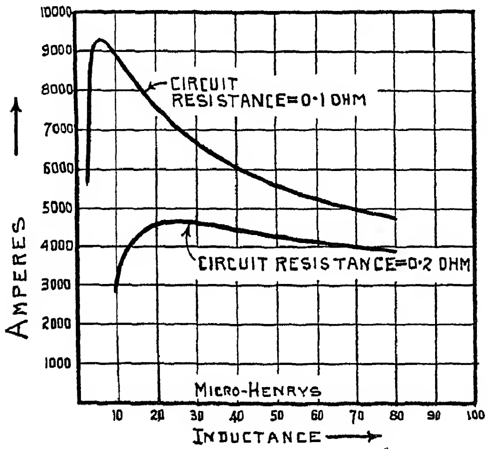


FIG 1.

the maximum value of the condenser discharge current which can be obtained by this method. The magnitude of the first peak of the discharge current is given by the expression

$$\frac{V}{L\sqrt{\frac{1}{LC}-\frac{1}{4}\frac{R^2}{L^2}}}e^{-\frac{1}{2}\frac{R}{L}T} \text{ amperes,}$$

where

V volts is the pressure to which the condenser is charged.
L henry is the inductance of the circuit.
C farad is the total condenser capacity.
R ohm is the resistance of the circuit.
T second is the time for a quarter-period of the discharge current.
$e = 2{\cdot}718$ and is the base of natural logarithms.

In Fig. 1 the magnitude of the first peak of the discharge current is shown as a function of the inductance when the condenser capacity is 700 micro-farads and the pressure 2000 volts. Two cases have been selected, namely, (i.) for a circuit resistance of 0·1 ohm, and (ii.) for a circuit resistance of 0·2 ohm.

It is important to observe that the maximum value of the first peak of the discharge current is obtained for a definite value of the inductance, and that this maximum value is more sharply defined the smaller the resistance of the circuit. T. F. WALL.

Edgar Allen Research Laboratory,
University of Sheffield,
August 30.

Absorption of Vapours of Various Liquids by Cotton.

THE familiar absorption of water from the air by cotton has been studied in our laboratories for some years from various aspects. The phenomena are valuable as clues for interpreting the physico-chemical structure of cotton cellulose, and in this connexion we have naturally examined the capillary hypothesis, using Anderson's formula for calculation of capillary radii. We recently initiated a simple series of observations which indicate that this hypothesis is inadequate, by showing that the weight of vapour absorbed is dependent on the chemical nature of the vapour, with a suggestion that there is a constant "low level" group, including definite types of liquids, with which the values are due to simpler causes than with water or acetic acid, the values for the two latter being far higher. As the differences for various liquids are very marked and do not seem to have been previously recorded, the following particulars may be of interest, in spite of the primitive methods used in what was merely a preliminary examination.

Samples of unbleached and bleached twofold Egyptian cotton hosiery yarn were suspended, at room temperatures, in a bottle, in the bottom of which was a layer of the liquid under consideration. The cotton (which before enclosure had been dried for four hours in a water oven and then weighed) was withdrawn, with suitable precautions, at intervals of several hours and weighed in a weighing bottle. Curves were drawn through the plottings of these weight-values in order to show approximately the variation of weight with time for water, alcohol, acetic acid, benzene, nitrobenzene, carbon disulphide, ether and acetone. The following table shows only the saturation values at room temperatures:

Liquid.	Unbleached	Bleached.
	Per cent.	Per cent.
Water	18 to 20	19 to 21
Glacial acetic acid	18 ,, 20	17 ,, 19
Absolute alcohol	3 ,, 3½	8½ ,, 9
Carbon disulphide	1½ ,, 2	1½ ,, 2
Benzene	1½ ,, 2	1 ,, 2
Ether	7 ,, 7½	7 ,, 7½
Nitrobenzene	1½ ,, 2	1½ ,, 2
Acetone	2 ,, 2½	6½ ,, 7

It is intended to investigate these phenomena further in the Experimental Department of the Fine Cotton Spinners' and Doublers' Association, to which I am indebted for permission to publish this note.

ROBERT C. BRIMLEY.

Rock Bank, Bollington,
near Macclesfield, Cheshire,
August 29.

The Magnetic Resolution of the Scandium Lines.

SEVERAL lines of the scandium spectrum have been classified by Catalán (An. Soc. Esp., 20, 606, 1922, and 21, 464, 1923). According to him, the Sc I. spectrum contains a doublet- and a quartet-term system; the Sc II. spectrum a triplet-system. It is, however, probable that some corrections must be made in his term-scheme. These corrections are obviously also made by Gieseler and Grotrian (*Naturw.*, 12, 438, 1924).

We have made provisional measurements of the magnetic resolution of some scandium-lines. By means of the formulæ given by Landé (*Zeit. f. Phys.*,

15, 189, 1923), it has been possible to calculate the greater part of these resolution patterns from the corrected term-scheme. The observations agree completely with the calculations on the assumption that the ordinary formula for the "separation factor" g of Landé is valid.

The observations of a few other lines make it not improbable, however, that there may be some terms for which the ordinary formula does not apply It follows also, from some earlier observations of Rybar (*Physik Zeit.*, 12, 889, 1911) on the related triplet spectrum of lanthanum, that terms with ordinary resolution and terms with unusual resolution are both present.

According to Landé (*Zeit. f. Phys.*, 17, 292, 1923) the ordinary g-formula is only valid if in the atomic rest—that is, the atom without the emitting electron—the electrons of the groups with azimuthal quantum numbers greater than one form closed configurations without moment of momentum.

The neutral scandium atom contains, according to Bohr, one single 3_3-electron. The observed separation patterns show that this single 3_3-electron generally cannot be present in the atomic rest of the excited scandium atom, for it cannot be arranged in a closed configuration. Therefore, it must be the emitting electron. The term-scheme really shows that the lowest energy level is a d-term, and this is also confirmed by the absorption experiments of Gieseler and Grotrian (*l.c.*). In the ionised scandium atom, there is no 3_3-electron at all, or it must be also in this case the emitting electron. The lowest energy level of Sc II. is not yet known.

It should be noted, however, that the facts obtained with the spectra of vanadium and titanium (Gieseler and Grotrian, *l c.*) show that the term-type determined by means of the term structure and the magnetic resolution is not always (perhaps through the simultaneous action of different outer electrons) the one we expect according to the known atomic structure. It may be possible that something of this kind also happens here.

S. Goudsmit.
P. Zeeman.

Amsterdam, August 20

Congenital Eye Anomalies in Albino Mice.

In papers published in the *Journal of Experimental Zoology* (vol. xxvi., 1918, p 65, and xxxi, 1920, p. 171) Guyer and Smith have given an account of the transmission, through successive generations, of eye defects which occurred in the offspring of rabbits and mice treated, while pregnant, with lens-sensitised fowl serum. The greater part of the papers concerns experiments carried out with albino rabbits, and in their case alone was the question of heredity considered, but the nature of the defects in both cases appears to have been the same.

Among a large number of albino white mice which are being bred in this Laboratory, a few have appeared recently with abnormal eyes. These have arisen in the course of ordinary breeding. The eyes follow in appearance the description given by Guyer and Smith; they are sometimes reduced in size, and one or both lenses are opaque, so that they are of a colourless, glassy hue instead of the normal red of the albino. So far the abnormality has been noticed in about 1½ per cent. of the mice that have been dealt with, and while it is at present too early to assert that the defect is definitely hereditary, the evidence available suggests that this is so

I should be very interested to hear whether any others who have been breeding mice have observed this same abnormality. Guyer and Smith could obtain no information from breeders of similar defects arising naturally in *rabbits*, and concluded that "rabbits are stable forms wholly unlikely to develop eye defects unless, as in our work, these have been deliberately induced by the experimenter" It would appear that as regards albino mice, outwardly similar defects may arise without being deliberately induced, which seems to be a fact of some importance having regard to the bearing of Guyer and Smith's experiments on the problem of the inheritance of acquired characters.

Egon S Pearson.

Biometric Laboratory,
University College,
London.

The Stark Effect on Fundamental (Bergman) Series.

According to the Bohr theory, we should expect that the Stark effect would be strong in the fundamental (Bergman) series So far as I am aware, the experimental evidence has not been brought forward, as the lines belonging to this series usually appear in the infra-red region In a paper published by Saunders (*Astrophys. Jour.*, 52, p. 265, 1920) a certain number of calcium lines in the visible and ultra-violet region are ascribed to the fundamental series.

On referring to my previous work with Mr. N. Kokubu (Mem. Coll. of Sci., Kyoto, 3, p. 173, 1918), I find that many of these fundamental series lines are shifted toward the red by an electric field, as shown in the following table.

	Fundamental triplets $(1d)-(mf)$.				Fundamental Singlets $(1D)-(mF)$.		
m	λ in A	Shifts (for E = 68 kilovolt/cm)		m	λ in A	Shifts (for E = 68 kilovolt/cm.)	
1	4586·1 81 7 78·8	Not measured		1	4878 3	Not measured	
		p-component	s-component			p-component	s-component
2	4098·8	2·7 A	1·2 A	2	4355·4	4·3 A	2·8 A
	95 3	2·3 A	1·5 A				
	92 9	2 2 A	1·4 A				

On meeting Prof. Saunders at Toronto during the sessions of the British Association, he suggested that this fact might be worthy of mention.

T. Takamine.

Photographs of Lightning.

I am at present engaged in investigating the forms assumed by lightning flashes in different circumstances and for this purpose require to examine as many photographs of lightning as possible. May I appeal to readers of Nature who have such photographs to be good enough to give me an opportunity of inspecting them? It is not necessary that the photographs should be technically good, any photographs showing the form of the flash will be valuable. I should like especially to see photographs showing flashes from the tops and sides of clouds.

All photographs will be returned, if required, as soon as they have been examined.

G. C. Simpson.

Meteorological Office, Air Ministry,
Adastral House, Kingsway,
London, W.C.2,
September 10.

Present-day Problems in Crop Production.[1]

By Sir E. JOHN RUSSELL, F.R.S.

COMPLEXITY OF THE PROBLEM.

THE agricultural investigator is confronted with three closely interlocking agencies—the plant, the climate, and the soil—each of which is variable within certain limits, and each playing a large part in the crop production which it is his business to study.

Confronted with a problem of this degree of complexity there are two methods of procedure: the empirical method of field observations and experiments, in which there is no pretence of great refinement and no expectation that the same result will ever be obtained twice, it being sufficient if over an average of numerous trials a result is obtained more often than would be expected from the laws of chance; and the scientific method, in which the factors are carefully analysed and their effects studied quantitatively; a synthesis is then attempted, and efforts are made to reconstruct the whole chain of processes and results. The scientific method is, of course, the one to which we are naturally attracted. But common truthfulness compels one to admit that up to the present the greatest advances in the actual production of crops have been effected by the empirical method, and not infrequently by men who are really artists rather than men of science, in that they are guided by some intuitive process which they cannot explain, and that they have the vision of the result before they obtain it, which the scientific man commonly has not.

The best hope for the future lies in the combination of the empirical and the scientific methods. This is steadily being accomplished by the recent strong infusion of science into the art of field experimentation, which has much enhanced the value of the field work and the trustworthiness of its results. Modern methods of replication, such as have been worked out at Rothamsted, and in the United States by Harris of the Carnegie Trust (Cold Spring Harbor), Kiesselbach in Nebraska, Myers and Love of Cornell, and others, constitute a marked improvement in plot technique. The figures themselves, besides being more accurate, can be made to yield more information than was formerly the case.

Great advances have been made in the methods of analysing the results. The figures are never the same in any two seasons, since the climatic conditions profoundly affect the yields. A few men, like J. H. Gilbert, have the faculty of extracting a great deal of information from a vast table of figures, but in the main even the trained scientific worker can make very little of them. The reason is that he has been brought up to deal with cases where only one factor is varying, while the growth of plants involves the interaction of three variable factors: the plant, the soil, and the climate. It is impossible to apply in the field the ordinary methods of the scientific investigator where single factors alone are studied; very different methods are needed, adapted to the case where several factors vary simultaneously.

Fortunately for agricultural science, statisticians have in recent years worked out methods of this kind, and these are being modified and developed by R. A. Fisher and Miss Mackenzie for application to the Rothamsted field data. It so happens that this material is very suitable for the purpose, since a large number of the field experiments have been repeated every year for seventy or eighty years on the same crop and on the same piece of land, using the same methods; the field workers also remain the same for many years, the changes being rare and without break in continuity. Although the statistical investigation is only recently begun, mathematical expression has already been given to the relationship between rainfall and yield of wheat and barley under different fertiliser treatments, and precision has been given to some of the ideas that have hitherto been only general impressions. If on an average of years a farmer is liable to a certain distribution of rainfall, it is becoming possible to advise as to fertiliser treatment which enables the plant to make the best of this rainfall.

ALTERATIONS IN THE PLANT.

It is a commonplace among farmers that certain soil conditions influence not only the yield but also the quality of crops. The leaf and root are more easily affected than the seed. The case of mangolds has been investigated at Rothamsted; the sugar content of the root, an important factor in determining feeding value, was increased by increasing the supply of potassium to the crop. Middleton at Cockle Park showed that grass increased in feeding value—quite apart from any increase in quantity—when treated with phosphates. Potatoes are considerably influenced by manuring; increasing the supply of potassium influences the composition of the tubers and also that much more impalpable quality—the cook's estimate of the value of the potato; while we have found at Rothamsted that a high-class cook discriminated between potatoes fertilised with sulphate of potash and those fertilised with muriate of potash, giving preference to the former.

Grain is more difficult to alter by changes in environmental conditions; indeed, it appears that the plant tends to produce seed of substantially the same composition whatever its treatment—with the important exception of variation in moisture supply. Mr. Shutt has explored the possibilities of altering the character of the wheat grain by varying the soil conditions, and finds that increases in soil moisture decrease the nitrogen in the grain. Similar results have been obtained in the United States.

On the other hand, in England the reverse seems to hold, at any rate for barley. This crop is being fully investigated at the present time under the research scheme of the Institute of Brewing, because of its importance in the preparation of what is still Britain's national beverage. Increased moisture supply increases the percentage of nitrogen in the grain, and so also does increased nitrogen supply, though to a much less extent; on the other hand, both potassic and phosphatic fertilisers may decrease the percentage of nitrogen, though they do not always do so; the laws regulating their action are unknown to us.

[1] From the presidential address delivered to Section M (Agriculture) of the British Association, Toronto, August 11.

The practical importance of these problems of regulating the composition of the plant lies in the fact that the farmer can control his fertiliser supply, and also to some extent his moisture supply, so that it lies within his power to effect some change should he wish to do so.

In agricultural science one sometimes thinks only of the crop and the factors that affect its growth. But in agricultural practice there is often another partner in the concern: a pest or parasite causing disease. The amount of damage done by pests and diseases to agricultural crops is astounding; in Britain it is probably at least 10 per cent. of the total value of the crops and the loss is probably some 12,000,000*l.* sterling per annum; in some countries it is considerably more. Indeed, the number of insect pests and of harmful fungi and bacteria that skilled entomologists and mycologists have found in our fields might almost lead us to despair of ever raising a single crop, but fortunately the young plant, like the human child, grows up in spite of the vast number of possible deaths. The saving fact seems to be that the pest does harm only when three sets of conditions happen to occur together: the pest must be present in the attacking state; the plant must be in a sufficiently receptive state; and the conditions must be favourable to the development of the pest. It is because this favourable conjunction of conditions comes but rarely that crops manage to survive; and this gives us the key to control if only we knew how to use it. Complete control of any of these three conditions would end all plant diseases. Unfortunately, control is never complete even in glasshouse culture, still less out of doors. But even partial control would be very helpful. All these pests go through life cycles, which are being studied in great detail all over the world, and especially in the United States. Somewhere there occurs a stage which is weaker or more easily controlled than others, and the pest would become harmless if the chain could be broken here or if the cycle could be sufficiently retarded to give the plant a chance of passing the susceptible stage before it is attacked.

The plants themselves, as we have just seen, are in some degree under control, and if they could be pushed through the susceptible stages before the pest was ready, they would escape attack. Barley in England is sometimes considerably injured by the gout fly (*Chlorops tæniopus*). The larvæ emerge in spring from the eggs laid on the leaves and invariably crawl downwards, entering the young ear if, as usually happens, it still remains ensheathed in leaves. J. G. H. Frew, at Rothamsted, has shown that early sowing and suitable manuring cause the ear to grow quickly above the track of the larvæ, and thus to escape injury. E. A. Andrews, in India, has found that tea bushes well supplied with potassic fertiliser escape attack from the mosquito bug (Helopeltis) for the rest of the season, apparently because bushes so treated become unsuitable as food to the pest. Further, the conditions are alterable. H. H. King, in the Sudan, has effected some degree of control of the cotton thrips (*Heliothrips indicus*) by giving the plant protection against the drying north wind and so maintaining a rather more humid atmosphere—a condition in which the plant flourishes more than the pest. Tomatoes in England suffered greatly from Verticillium wilt until it was found that a small alteration of temperature threw the attack out of joint. They are also much affected by stripe disease (*B. lathyri*), but they become more resistant when the supply of potash is increased relative to the nitrogen. It has recently been maintained, though the proof is not yet sufficient, that an altered method of cultivating wheat in England will afford a good protection against bunt. These cultural methods of dealing with plant diseases and pests offer great possibilities, and a close study jointly by plant physiologists and pathologists of the responses of the plant to its surroundings, and the relationships between the physiological conditions of the plant and the attacks of its various parasites, would undoubtedly yield results of great value for the control of plant diseases. Again, however, the plant breeder can save a world of trouble by producing a variety resistant to the disease; or there may fortunately be found an immune plant from which stocks can be had, as in the case of the potatoes found by Mr. Gough to be immune to the terrible wart disease.

CONTROL OF ENVIRONMENTAL FACTORS.

It thus appears that, if only plant breeders and plant physiologists could learn to alter existing plants or to build up new plants in such a way that they should be well adapted to existing soil and climate conditions, and not adapted to receive disease organisms at the time the organisms are ready to come—if only they could do this, all agricultural land would become fertile and plant diseases and pests would become ineffective: at any rate until the pests adapted themselves to the new plants. Although no one can set limits to the possibilities of plant breeding and plant physiology, we cannot assume that we are anywhere near this desirable achievement or that we are likely to be in our time.

There will always remain the necessity for altering the environmental conditions to bring them closer to the optimum conditions for the growth of the plant. No attempt is yet made in the field to control two of the most important of the factors: the light and the temperature, though it is being tried experimentally. There is a great field for future workers here; at present plants utilise only a fraction of the radiant energy they receive. At Rothamsted attempts have been made by F. G. Gregory to measure this fraction; the difficulties are considerable, but the evidence shows that our most efficient plants lag far behind our worst motor-cars when regarded as energy transformers for human purposes. One hundred years ago the efficiency of an engine as a transformer of energy was about 2 per cent.; now, as a result of scientific developments, it is more than 30 per cent. To-day the efficiency of the best field crops in England as transformers of the sun's energy is about 1 per cent.:[2] can we hope for a similar development in the next hundred years? If such an increase could be obtained an ordinary crop of wheat would be about 400 bushels per acre, and farmers would feel sorry for themselves if they obtained only 200 bushels. But we are only at the beginning of the subject. Increases in plant growth amounting to some

[2] The remaining energy being largely used up in transpiration. This figure refers to the total radiation received by the leaf, and not to the fraction received by the chloroplast surface. For this latter the value is much higher

Present-day Problems in Crop Production.[1]

By Sir E. John Russell, F.R.S.

Complexity of the Problem.

The agricultural investigator is confronted with three closely interlocking agencies—the plant, the climate, and the soil—each of which is variable within certain limits, and each playing a large part in the crop production which it is his business to study.

Confronted with a problem of this degree of complexity there are two methods of procedure: the empirical method of field observations and experiments, in which there is no pretence of great refinement and no expectation that the same result will ever be obtained twice, it being sufficient if over an average of numerous trials a result is obtained more often than would be expected from the laws of chance; and the scientific method, in which the factors are carefully analysed and their effects studied quantitatively; a synthesis is then attempted, and efforts are made to reconstruct the whole chain of processes and results. The scientific method is, of course, the one to which we are naturally attracted. But common truthfulness compels one to admit that up to the present the greatest advances in the actual production of crops have been effected by the empirical method, and not infrequently by men who are really artists rather than men of science, in that they are guided by some intuitive process which they cannot explain, and that they have the vision of the result before they obtain it, which the scientific man commonly has not.

The best hope for the future lies in the combination of the empirical and the scientific methods. This is steadily being accomplished by the recent strong infusion of science into the art of field experimentation, which has much enhanced the value of the field work and the trustworthiness of its results. Modern methods of replication, such as have been worked out at Rothamsted, and in the United States by Harris of the Carnegie Trust (Cold Spring Harbor), Kiesselbach in Nebraska, Myers and Love of Cornell, and others, constitute a marked improvement in plot technique. The figures themselves, besides being more accurate, can be made to yield more information than was formerly the case.

Great advances have been made in the methods of analysing the results. The figures are never the same in any two seasons, since the climatic conditions profoundly affect the yields. A few men, like J. H. Gilbert, have the faculty of extracting a great deal of information from a vast table of figures, but in the main even the trained scientific worker can make very little of them. The reason is that he has been brought up to deal with cases where only one factor is varying, while the growth of plants involves the interaction of three variable factors: the plant, the soil, and the climate. It is impossible to apply in the field the ordinary methods of the scientific investigator where single factors alone are studied; very different methods are needed, adapted to the case where several factors vary simultaneously.

Fortunately for agricultural science, statisticians have in recent years worked out methods of this kind, and these are being modified and developed by R. A. Fisher and Miss Mackenzie for application to the Rothamsted field data. It so happens that this material is very suitable for the purpose, since a large number of the field experiments have been repeated every year for seventy or eighty years on the same crop and on the same piece of land, using the same methods; the field workers also remain the same for many years, the changes being rare and without break in continuity. Although the statistical investigation is only recently begun, mathematical expression has already been given to the relationship between rainfall and yield of wheat and barley under different fertiliser treatments, and precision has been given to some of the ideas that have hitherto been only general impressions. If on an average of years a farmer is liable to a certain distribution of rainfall, it is becoming possible to advise as to fertiliser treatment which enables the plant to make the best of this rainfall.

Alterations in the Plant.

It is a commonplace among farmers that certain soil conditions influence not only the yield but also the quality of crops. The leaf and root are more easily affected than the seed. The case of mangolds has been investigated at Rothamsted; the sugar content of the root, an important factor in determining feeding value, was increased by increasing the supply of potassium to the crop. Middleton at Cockle Park showed that grass increased in feeding value—quite apart from any increase in quantity—when treated with phosphates. Potatoes are considerably influenced by manuring; increasing the supply of potassium influences the composition of the tubers and also that much more impalpable quality—the cook's estimate of the value of the potato; while we have found at Rothamsted that a high-class cook discriminated between potatoes fertilised with sulphate of potash and those fertilised with muriate of potash, giving preference to the former.

Grain is more difficult to alter by changes in environmental conditions; indeed, it appears that the plant tends to produce seed of substantially the same composition whatever its treatment—with the important exception of variation in moisture supply. Mr. Shutt has explored the possibilities of altering the character of the wheat grain by varying the soil conditions, and finds that increases in soil moisture decrease the nitrogen in the grain. Similar results have been obtained in the United States.

On the other hand, in England the reverse seems to hold, at any rate for barley. This crop is being fully investigated at the present time under the research scheme of the Institute of Brewing, because of its importance in the preparation of what is still Britain's national beverage. Increased moisture supply increases the percentage of nitrogen in the grain, and so also does increased nitrogen supply, though to a much less extent; on the other hand, both potassic and phosphatic fertilisers may decrease the percentage of nitrogen, though they do not always do so; the laws regulating their action are unknown to us.

[1] From the presidential address delivered to Section M (Agriculture) of the British Association, Toronto, August 11.

THE SOIL MICRO-ORGANISMS.

It is now more than forty years since the discovery of the great importance of micro-organisms in determining soil fertility. Practical applications necessarily lag far behind; but already three have been made each of which opens out great possibilities for the future. The long-standing problem of inoculation of leguminous crops with their appropriate organisms has already been solved in one or two of its simple cases, chiefly lucerne on new land, and the new process has helped in the remarkable extension of the lucerne crop in the United States and in Denmark. We believe at Rothamsted that the more difficult English problem is now solved also. Interesting possibilities are opened up by the observation that a preliminary crop of Bokhara clover seems to facilitate the growth of the lucerne.

The organisms effecting decomposition are now coming under control, and are being made to convert straw into farmyard manure (or a material very much like it) without the use of a single farm animal. The process was worked out at Rothamsted, and is being developed by the Adco Syndicate, which is now operating it on a large scale and is already converting some thousands of tons of straw annually into good manure.

The third direction in which control of the soil organisms is being attempted is by partial sterilisation. This process is much used in the glasshouse industry in England, and it has led to considerable increases in crop yields. The older method was to use heat as the partial sterilising agent, and this still remains the most effective, but owing to its costliness, efforts have been made to replace it by chemicals. Considerable success has been attained; we have now found a number of substances which seem promising. Some of these are by-products of coal industries; others, such as chlor- and nitro-derivatives of benzene or cresol, are producible as crude intermediates in the dye industry.

THE NEED FOR FULLER CO-OPERATION.

Looking back over the list of problems it will be seen that they are all too complex to be completely solved by any single worker. Problems of crop production need the co-operation of agriculturists, plant physiologists, soil investigators, and statisticians. Even plant breeding necessitates the help of a physiologist who can specify just what the breeder should aim at producing. This gives the key-note to the period of agricultural science on which we have now entered—it is becoming more and more a period of co-operation between men viewing the problem from different points of view. Good individual work will of course always continue to be done, but the future will undoubtedly see a great expansion of team work such as we know from our experience at Rothamsted is capable of giving admirable results in agricultural science.

With fuller co-operation both of men and of institutions we could do much to overcome the present difficulty in regard to utilising the information we already possess. In the last thirty years an immense stock of knowledge has been obtained as to soils and crops. It is stored in great numbers of volumes which line the shelves of our libraries, and there much of it rests undisturbed in dignified oblivion. In the main it consists of single threads followed out more or less carefully; only rarely does some more gifted worker show something of the great pattern which the threads compose. But even the most gifted can see but little of the design; the best hope of seeing more is to induce people to work in groups of two or three, each trained in a different school and therefore looking at the problem from a different point; each seeing something hidden from the rest. Unlike art, science lends itself to this kind of team work; art is purely an individual interpretation of Nature while science aims at a faithful description of Nature, all humanistic interpretation being eliminated. There is certainly sufficient good will among the leaders of agricultural science to justify the hope of co-operation; there are probably in existence foundations which would furnish the financial aid.

This leads to my last point. What is the purpose of it all? Team work, co-operation, the great expenditure of time and money now being incurred in agricultural science and experiment—these are justified only if the end is worthy of the effort. The nineteenth century took the view that agricultural science was justified only in so far as it was useful. That view we now believe to be too narrow. The practical purpose is of course essential; the station must help the farmer in his daily difficulties—which again necessitates co-operation, this time between the practical grower and the scientific worker. But history has shown that institutions and investigators that tie themselves down to purely practical problems do not get very far; all experience proves that the safest way of making advances, even for purely practical purposes, is to leave the investigator unfettered. Our declared aim at Rothamsted is "to discover the principles underlying the great facts of agriculture and to put the knowledge thus gained into a form in which it can be used by teachers, experts, and farmers for the upraising of country life and the improvement of the standard of farming."

This wider purpose gives the investigator full latitude, and it justifies an investigation whether the results will be immediately useful or not—so long as they are trustworthy. For the upraising of country life necessitates a higher standard of education for the countryman; and education based on the wonderful book of Nature which lies open for all to read if they but could. How many farmers know anything about the remarkable structure of the soil they till, of its fascinating history, of the teeming population of living organisms that dwell in its dark recesses; of the wonderful wheel of life in which the plant takes up simple substances and in some mysterious way fashions them into foods for men and animals and packs them with energy drawn out of the sunlight—energy which enables us to move and work, to drive engines, motor-cars, and all the other complex agencies of modern civilisation? No one knows much of these things; but if we knew more, and could tell it as it deserves to be told, we should have a story that would make the wildest romance of human imagination seem dull by comparison and would dispel for ever the illusion that the country is a dull place to live in. Agricultural science must be judged not only by its material achievements, but also by its success in revealing to the countryman something of the wonder and the mystery of the great open spaces in which he dwells.

Recent Work at Stonehenge.

By Lieut.-Col. WILLIAM HAWLEY.

CONSIDERABLE progress has been made during the last two years in the work of excavation which is being carried out at the site of Stonehenge, and although nothing giving any clue to the age and purpose of the monument has yet been discovered, many places in the area surrounding it have yielded matter of much interest and importance.

In order to find out the conditions of the Avenue and its relation to the place, an excavation of the ditch around the circular rampart was begun about 40 feet from where it would approach the south bank of the Avenue. The ditch was 6 feet deep where digging began, suddenly rising soon afterwards to a level 3 feet higher, but gradually returning to nearly the former depth as it went onwards. When the line of the Avenue bank was reached, there was no trace of it meeting the ditch, which passed on for about 25 feet beyond the spot and ended against a very upright bank of solid chalk about 5 feet high, widening and taking a roughly circular form with a flat bottom An excavation, in the line of the ditch, made about 50 feet beyond this obstruction revealed a similar solid side. The intervening portion, which was 40 feet wide, proved to be a causeway of natural chalk which crossed the ditch and afforded an entrance to the circular enclosure. The ending of the ditch on the west was roughly circular like that on the east side, but here it formed a large wide pit 7½ feet deep communicating with another beyond it through a narrow opening. Both bore traces of fires at the bottom, and scattered around them were horn picks, bones of animals, and quantities of flint flakes.

The surface of the causeway was very remarkable as it was studded with 58 holes, more or less in regular lines, occupying the entire length and width of it. These were probably of the same age as the ditch, and with it seem to have been for defence and resisting combined attack, pointing to the place in its early history being one of defence.

In the entrance and in line with the rampart crest a large stone hole was found close to another previously excavated, the latter being the one the "Slaughter" stone is thought to have stood in.

Excavation afterwards included the portion of the Avenue between the entrance and the fence at the high road. The small side banks and ditches of it begin 10 feet from the main ditch, showing that the Avenue was independent of it and probably of later construction. Formerly it was believed that the Avenue entered Stonehenge, but it is now seen that the actual entrance was over the causeway, mentioned above, and only about half as wide. The Avenue is 70 feet wide where it begins, but the ditches are irregular in their alignment, carelessly dug, and of a variable depth of about 3 feet.

The ditches have a layer of silt upon the bottom, reaching half-way up, which contains nothing of the Stonehenge period, but the stratum over it does, so it might be inferred from this that the Avenue preceded Stonehenge by a considerable interval. Evidence of the Stonehenge period is gained from a stratum which varies from an inch or two to 15 inches in depth and is distributed with very fair evenness over the whole surface of the place. It contains the mason's chips and things that belong to and after that period alone, and therefore is a most useful guide for determining periods which precede and those which follow after the making of the monument, helping also to show that it is of Neolithic age. It has been necessary to make this digression in order that the context may be more clearly understood.

There were two large holes found near the Helestone, and there can be little doubt that they once held stones, and their filling of loose chalk was that which fell back when they were extracted. Over one of them there was a dump of nearly four thousand sarsen chippings and sandy debris, showing that a stone had been dressed on the spot, and no doubt taken from the hole and, after preparation, used for the monument. It seems from this that there may have been a certain number of rough sarsens already *in situ* here before Stonehenge was built. Each of the stones was 40 feet from the Helestone and suggest that a little group might have stood there independently of anything that might have been standing within the circle at the time.

A trench 4 feet wide was found around the Helestone, but only a part was excavated, as the remainder is covered by the high road. Like the small ditches, it had been half filled with silt, which had chips in the filling over it, but not in it, thus showing an earlier origin than Stonehenge.

Three large post holes occurred westward from the Helestone, with distances equally divided. They resembled those on the causeway and were certainly of early date, as the Avenue bank on the west covered two of them. The remainder of the Avenue was quite barren of anything of interest and had been much eroded by a medieval coach road and country traffic.

Excavation was afterwards transferred to the interior of the circular enclosure, and a systematic search began of the land within by cutting trenches in close succession over it from the rampart nearly up to the standing stones. Last year 107 trenches were opened and the N.E. quadrant accounted for, and this year it is hoped to complete the S.E. quadrant. The trenches were mostly over shallow ground and, on the whole, not very productive, but some of them certainly afforded places giving much information and interest.

The first line of trenches was directed towards the entrance at the standing stones, and, after proceeding a little way, holes were come to of a sharply cut, rectangular, oblong form, measuring about 5 feet long by 3 feet wide at the top, tapering in a wedge shape to a narrow bottom. These were found to extend in a regular succession in two rows around the outer circle, the holes of each new circle being exactly opposite standing stones. It was afterwards ascertained by sounding that similar cavities exist around the present outer circle, indicating that there were once two extra circles to the monument. For the sake of reference they have been called Y and Z circles. The first holes of the former began at 38 feet from the standing stones, and the latter 10 feet distant. Their side intervals are

regular but they are not concentric with the standing circle nor in relation to themselves. The distance from the outer circle gradually diminishes from where they begin at the entrance until No. 8 is reached, after which they take up the original distance; this applies to both circles. Some confusion was noted where the irregularities terminated; No. 7 hole had been only partly dug, and Z8 was found not to exist.

It can be clearly proved that these holes were made in the Stonehenge period, because the mason's chips were present in the filling and even upon the bottom. The first four holes excavated occur in the fairway from the entrance, and it may be safely said that they never held stones. Although dug for the purpose, consideration afterwards led them to leave the holes empty, as the stones would have been inconvenient in the fairway. Their sharpness and undisturbed condition showed there had been no insertion and extraction of stones; moreover, one of them contained five stag antlers and another a single antler, showing absence of stones. The other holes showed disturbances caused by extracting stones. Soil had fallen back, partly filling the holes, and over it was a more recent stratum bearing objects from the time of extraction to the present day. Romano-British objects were found in the upper stratum, and in one hole, about 18 to 20 inches from the top, there was dirty soil mixed with wood ashes and some natural flints arranged apparently as a temporary hearth, and on the same level were 42 pieces of a Romano-British pot. A little below this level were three pieces of fine, gritty pottery belonging to the "La Tene" period. This gives the impression that the stone was extracted at that time, and that spoliation on the site might have begun at quite an early date.

Where the irregularity occurred at No. 8, a considerable area was opened out to try to discover a reason for it, but with not much success. A great many post holes were met with, and, since then, a still greater number have been found extending from this spot towards the rampart, some of them taking the form of parallel lines; these are now in course of investigation. They are evidently of quite early date, as the Stonehenge stratum passes over them and they contain nothing of that period. Eleven of them, about 6 feet apart, formed a long row, the last two holes at one end having been united by digging to form a grave at a time when posts no longer stood there, the holes and loose matter affording less trouble in digging one. A skeleton found in it proved to be that of a person belonging to a long-headed race existing shortly before the Roman occupation. Owing to insufficient length and capacity of the grave (barely 3 feet deep) the remains were much crushed, but have nevertheless been reconstructed.

Remains of the Bronze age do not occur until after the erection of Stonehenge and are found in the upper stratum consisting chiefly of foot-worn fragments of pottery. With a cremation of that period there was found a beautifully ground and polished mace head of the "cushion" type. The stone is hornblendic gneiss and probably came from Brittany. Eight other specimens are known to exist of that type, now in collections, five of them coming from Scotland and three from the Thames and its neighbourhood, and they are regarded as ceremonial maces of that period. With another cremation a very fine bone pin 7 inches long was found. It had been burnt with the body and was much twisted by heat and broken in three places, but was easily mended. The cremated remains are usually found but a short distance below ground, most of them actually without cists in the loose chalk rubble at the foot of the rampart; sometimes the remains are found clinging to a turf when it is cut and turned over. This shows that the rampart conditions cannot have been very different then from what we see them now. The impression created during the continuance of excavation here makes one aware that a long succession of events is being dealt with which have covered a vast number of years. The silting of the main ditch alone is a proof of this. This process must have taken a very long time, for sometimes there are 6 feet of it and not a vestige of the Stonehenge era occurs in it, and is only met with as a narrow stratum below the turf and abruptly divided from it. Unfortunately, none of these matters have as yet given any information as to the date of the monument, but there is yet a great deal of ground to be opened, and by more time and diligent search it is hoped eventually to arrive at some clear conclusions.

Circumnavigation of the Earth by Aeroplane.

On April 6, four U.S.A. aeroplanes left Seattle on an air voyage of circumnavigation of the world. Five months later, on September 6, two out of the four arrived at Boston. Flying took place on 48 days out of 153 days thus consumed. The actual flying hours were 288; the distance covered was 21,500 miles. About every third day on the average was therefore a flying day of 6 hours flying at 75 miles per hour, giving a flying day's run of 450 miles.

The flight falls naturally into four stages, floats being fitted for stages 1 and 3, wheels for 2 and 4. New engines were fitted at the start, and in Japan, at Calcutta, and at Hull. New wings were fitted at Calcutta, and numerous subsidiary repairs and replacements were carried out. Cruisers, supply ships, and flotillas of destroyers were employed in the improvised organisation along the sea routes. Existing permanent organisations were available along the land routes.

In stage 1 the route runs along the Pacific Coast of Canada and Alaska, and crosses the northern entrance of the Pacific Ocean by the Aleutian Islands; thence it runs by Kamchatka and Japan round the Chinese and Burmese coast to Calcutta. The Aleutian Islands, in which aeroplane No. 1 fell out, are subject to fogs, squalls and blizzards, the Chinese seas to typhoons, and the southern arc, Saigon—Rangoon, to tropical heats. There is no permanent airway organisation in the first part of this stage, and in the second part the Japanese, French and British organisations are not continuous. In this stage as a whole, flying took place only on 22 days out of 82, 11,000 miles being covered in 158 flying hours.

At Calcutta 4 days were spent in fitting new engines, new wings, and wheels for the overland stage Calcutta—

London. Leaving Calcutta on July 1 and arriving at Hull on July 17, the aeroplanes flew on 15 days out of 17, covering a distance of 6500 miles in 74 flying hours. The advantage of a permanent ground organisation is evident, and to this is added the inherent advantage of wheels over floats in both weight and air resistance.

At Hull 11 days were spent in overhauling the aeroplanes and in fitting new engines, and floats for the passage of the northern entrance of the Atlantic by way of the Orkneys, Faroë Islands, Iceland, Greenland and Labrador. Leaving Hull on July 30, and arriving at Boston on September 6, the aeroplanes flew on 11 days out of 39, 4000 miles being covered in 56 flying hours. Aeroplane No. 3 fell out between the Orkneys and Iceland. The remaining stage is from Boston via New York to Washington, thence due west to Salt Lake City, and so back to Seattle. Fitted with wheels, and using a homogeneous national air organisation, there is high probability that the two surviving aeroplanes will complete expeditiously the circumnavigation of the earth by air, except in so far as they are detained by the hospitality of their countrymen at the landing places.

In drawing technical conclusions from the flight, no account can be taken of the great personal effort of the pilots and mechanics in thus facing successfully every sort of condition along 24,000 miles of route, unknown to them. The quasi-sporting condition that the same aeroplane bodies should circle the earth albeit with new engines, wings and other parts is also irrelevant. In a strictly utilitarian organisation fresh machines and pilots familiar with the route would be available for each 5-hour stage, and two such stages a day would be feasible. When it is found possible to maintain permanent airway organisation along such regions as the northern entrances of the Atlantic and Pacific Oceans, it may become possible, flying 10 hours a day at 100 miles per hour, to circumnavigate the world by air in about 24 days as a matter of routine travelling.

Obituary.

MR. HARTLEY LUPTON.

BY the death on September 6 of Mr. Hartley Lupton, at the early age of thirty-two years, physiology has lost a research worker of great industry and promise, his pupils a teacher who won their respect by his care and keenness and their affection by his simplicity and kindness, his friends at Manchester and at University College, London, a generous and devoted colleague. For generosity, simplicity, and devotion were the keynotes of Lupton's life. Stricken with a fatal illness in June, he spoke continually of returning to his beloved apparatus in a few weeks. Only a month before his death, at a time of great discomfort and distress, he read with appreciation and delight the manuscripts of three papers shortly to appear in the Proceedings of the Royal Society, describing the results of three years of devoted work. Rarely, until his last illness had completely incapacitated him, was he absent from the laboratory: he arrived first in the morning, he left last at night; he was always ready for any new experiment, any new enterprise, any extra work.

Lupton had an extraordinary capacity for friendship with young men, a capacity which served him well as a tutor at Dalton Hall, Manchester, and later in his physiological research work, where he continually needed "subjects" for his experiments. All who knew him will recall the pleasant and humorous picture of Lupton engaged in some experiment on severe muscular work, either on himself or some friend whom he had induced to take (at any rate temporarily) a sufficient interest in physiology to act as the subject of his—often rather strenuous—experiments. His own personal devotion can be gauged from the frequent entry "Subject, H. L. postabsorptive" in his records.

Lupton obtained a first-class honours degree in physics at the University of Manchester: the outlook of the physicist remained with him in his later work, and led to the scrupulous accuracy which is seen in all the records of his observations. His first independent scientific task was the routine work with radium at the Manchester Royal Infirmary. His experience there led his questioning mind to ask for the reason why radioactive bodies should have the effect they do on living tissues: the next step was to decide to take a medical degree, and it was as a student of physiology that the present writer first made his acquaintance. His teachers soon realised that Lupton was a person of rather singular interests and capacity, and an early opportunity occurred of starting him on physiological research. Working for the Medical Research Council, he took up the study of muscular exercise in man, based on the results of recent investigations of the isolated muscle. The subject proved fertile beyond expectation, and the results of it are contained in several papers published in the *Quarterly Journal of Medicine*, the *Journal of Physiology*, and the Proceedings of the Royal Society. When he began this work, three years ago, little was known of the connexion between the physiology of the muscle and that of human muscular exercise. Three years of continual labour—years probably the happiest of his life, for he was never so happy as when "going all out"—have discovered and explored a new subject, the important one of the recovery process after muscular effort in man. To the physiological world the subject will remain, one may hope, associated with his name: to his colleagues it will always recall the unceasing devotion and the simple kindness of their friend.

A. V. H.

PROF. B. I. SLOVZOV, professor of biochemistry in the University of Saratov, and later in the Medical School for Women, Petrograd, whose death is announced, was a pupil of A. Kossel and A. Danilevsky and is known mainly for his contributions to the study of tissue enzymes. Another Russian man of science who has died recently is Prof. N. P. Kravkov, professor of pharmacology in the Medical Academy, Petrograd. Prof. Kravkov was a pupil of Schmiedeberg, and his chief work was performed on isolated organs which he used mainly for investigating the action of drugs upon blood-vessels. His method of the isolated rabbit's ears for testing vasoconstrictor and vasodilator substances is known universally and used in every pharmacological laboratory. Lately he contributed interesting observations upon the coronaries of the human heart and the isolated human fingers. He had been interested in the past few years in the action of drugs in highly diluted solutions.

Current Topics and Events.

WE are glad to learn that Mr. Jowett, First Commissioner of Works, has now definitely refused to permit the sect of Latter-Day Druids, or "Church of the Universal Bond," to make use of Stonehenge for the burial of the ashes of their dead. In a letter to Lord Crawford, Mr. Jowett says, "I have decided that under no circumstances can any burials be permitted within the precincts of Stonehenge in the future." When the proposed desecration of the national monument became known, strong protests were raised against it, and in our issue of September 6, p. 364, we expressed the resentment generally felt in regard to the claims and intentions of the sect which contemplated such action. It would probably be difficult to prevent members of the sect from scattering ashes of certain of their dead members within Stonehenge, but we assume that no formal assembly for this purpose will be authorised. In his reply to a question in the House of Commons in July, Mr Jowett said that no objection would be raised to the use of the national monument for the proposed burial of such ashes, provided that there was "no serious disturbance of the ground," and the sect announced that no such disturbance was intended, as there would be "nothing in the nature of an interment." It is not yet clear whether the sect may hold a service within the precincts of Stonehenge and formally scatter the ashes of their dead upon the ground.

AN interesting event took place at the house of the Royal Photographic Society, 35 Russell Square, on Saturday afternoon, September 13, when a memorial tablet to William Henry Fox Talbot was unveiled in the Library by Dr. G. H Rodman, a past president of the Society. A distinguished company included Miss M Talbot and Mrs Stewart, grand-daughters of the distinguished investigator whose memory was honoured Dr. Rodman, after referring to the historical collection of experimental apparatus used by Fox Talbot and presented by Miss M Talbot to the Museum of the Royal Photographic Society, reviewed Talbot's photographic researches, which appear to have been commenced in 1834. In that year, on the lines of Schutze, Scheele, and Wedgwood, Talbot produced sun prints of lace and leaves on paper treated with silver nitrate and sodium chloride; in 1835 he secured an image on moist sensitised paper in the camera obscura on a bright day with an exposure of ten minutes. The results of his researches were communicated in 1839 to the Royal Society in two famous papers on photogenic drawing. In 1840, by the use of paper impregnated with silver iodide and gallo nitrate of silver, Talbot secured results in ten seconds. The process, which he termed the calotype process, was patented in 1841 after a means had been found to obtain positive prints from the negatives Dr. Rodman paid an eloquent tribute to the value of Fox Talbot's contribution to science through these researches, upon which the modern practice of photography is based The memorial, by Messrs George and Fred Hawkings, consists of a finely modelled portrait of Fox Talbot, executed in bronze, with decorative surroundings upon a marble background, and bears the inscription—"William Henry Fox Talbot, 1800–1877. This Memorial was erected by public subscription of photographers, 1922."

THREE years ago, the Notgemeinschaft der Deutschen Wissenschaft was formed for co-ordinating all help received in Germany for the learned staffs of universities, technical high schools, and other institutions. The third report of this society has been issued and can be obtained from the offices situated in the Schloss, the former residence of the Kaiser, Berlin, C2 Schloss, Portal 3. It seems that 1923–4 was a year of very real need indeed; the period lasting until November 1923, when a very adverse rate of exchange existed, making foreign purchases impossible, was followed by a period of great want of money, making not only foreign but also internal purchases difficult. In 1923, the Reichstag made three grants of money, although it was not in a position to pay immediately. The most valuable of these was made in October and consisted of 500,000 gold marks (approx. 27,000*l.*). It was not possible to continue the programme of buying the most important journals published during the War until the fall in the mark had ceased. The sum of 46,000 gold marks (2500*l.*) was expended on the libraries of 23 universities, 11 technical high schools, and 300 larger institutions Twenty-five copies of the Paris *Comptes rendus* had to supply all these institutions. Foreign periodicals were cut down to one-fortieth of pre-War supply, and journals in covers were circulated for two months at a time to the individual universities. It was only possible to buy sixty foreign books of average value 15 marks, for each institution, but this number was increased by gifts from Switzerland, Sweden, Norway, U.S.A., Spain, and Great Britain. During this period it was possible to publish 117 periodicals and 103 books in all fields of knowledge on the funds of the association. Many German firms helped the funds by providing apparatus for special researches Hajime Hoshi, of Japan, provides 2000 yen monthly for the period of three years for chemical research. The General Electric Company of America provided 12,500 dollars, to which German electrical firms added 1250 dollars, for electrophysical research under a committee consisting of Planck, Laue, Franck, Haber, Nernst, and Wien In all faculties it was possible to make grants to 100 people of 25 to 100 dollars for special researches and journeys. It is hoped that the financial situation this next twelve months will be such that Germany will be able to buy foreign periodicals and books and resume the international exchange of academic thought.

THE low temperature carbonisation of coal excites at the present time the widest interest. The intelligent member of the general public hears much of it as a solution of the smoke problem and that of the supply of liquid fuel. The truth is often difficult

to get, especially by those desirous of appraising the validity of inventors' claims. The information conveyed in a circular just issued by the Department of Scientific and Industrial Research will therefore attract widespread interest. The offer is made that the Fuel Research Staff of the Department will undertake to test, without fee, approved plant and processes for low temperature carbonisation, under certain conditions. Application must be made on forms obtainable at the offices of the Department, 16 Old Queen Street, Westminster, S.W 1. The gist of the conditions may be summarised as follows. Applicants are to furnish full information and facilities for prior inspection by officers of the Department to permit of a decision as to the justifiability of a test. If undertaken, the test will be made under the supervision of a member of the Fuel Research Staff. Applicants will have to provide all requisite facilities, including material, staff, labour and measuring instruments, considered necessary. Applicants may be represented during the test, but the decision as to duration and conduct of the test will rest with the officer of the Fuel Research Staff supervising. The Department reserves to itself the right to publish a report on the results of tests made.

NOT the least important of the departmental exhibits in the British Government Pavilion at the British Empire Exhibition, Wembley, is that illustrating the work of the Imperial Institute in promoting the use of little-known or new raw materials of the Empire. The exhibit directs attention to the principal branches of the Institute—the scientific and technical department, the technical information bureau, and the exhibition galleries—and illustrates by series of specimens and publications the nature of the work carried out by the departments and technical committees. A collection of British Empire timbers includes samples of little-known woods recommended for use in Great Britain by the Timbers Committee of the Institute and fully tested in the timber laboratory. The fibre exhibits include samples of cottons from Irak and Tanganyika, and an important exhibit of silk cocoons, reeled and thrown silk and fabrics woven therefrom, illustrates the endeavours of the Institute's Silk Committee to extend the production of raw silk within the British Empire. There is an interesting display of new materials suitable for paper-making, and of papers made from them. The investigations of plantation rubber, carried out in connexion with the Ceylon Rubber Research Scheme, are also illustrated. Other sections relate to the work on oil-seeds, essential oils, tobaccos, resins, tanning materials, and drugs; and there is a collection of economic minerals including tropical African coals; materials for pottery, brick, and cement manufacture, illustrated by specimens of products made from them at the Institute; and radio-active and other minerals. A free pamphlet describing the exhibits and the departments of the Institute has been issued and may be obtained at Wembley, or on application to the Director, Imperial Institute, London, S.W.7.

WE have received from Messrs. Thomas Firth and Sons, Ltd, a statement containing some of the essential features of their exhibit at the British Empire Exhibition. A very wide range of products has been gathered together. Firth's stainless steel is now so well known amongst engineers that considerable attention will doubtless be focussed on this branch of their manufactures. A selection of many different types of turbine blading is shown, including twelve blades removed from a 2000 KW. Westinghouse turbine (steam pressure 200 lb., superheat 200° F.) Nine of these are of 5 per cent nickel steel, the remainder are of Firth's stainless steel. The actual hours run were 12,809 in six cases and 29,989 in the remainder. All the nickel steel blades show very marked signs of erosion, being very rough and pitted; the edges also show distinct signs of fraying. Those which have given longest service are quite worn out The stainless steel blades, on the other hand, are as bright and as unaffected as the day on which they were inserted; the edges retain their initial sharpness and no signs of wear are apparent anywhere Turbine engineers will doubtless take note of this remarkable difference in properties A pump rod of similar steel which has been in use in an ammoniacal liquor pump is also shown. The life of carbon steel rods is never more than about six months. The stainless steel rod is worn only about $\frac{5}{64}$ths of an inch. Moreover the surface is smooth and polished and not badly scored as it is in the case of carbon steel rods. A rake end is shown which has been in use in a roasting furnace for treating zinc concentrates containing 28-30 per cent. of sulphur. This has already been in use for three months, whereas the total life of a similar article made of mild steel is only three weeks. Various other products are shown which indicate the superior service given by Firth's stainless steel.

THE *Weather Map* of the meteorological service of the Dominion of Canada for July has recently been received. It shows the mean temperature and the total precipitation for the month, and graphically the difference of temperature from the normal and the comparative amount of rain over the whole of Canada. Part of July was exceedingly hot in southern British Columbia and very warm in the North-western Provinces. There was a deficiency of temperature amounting to 4° F. or more in eastern Manitoba, northern Ontario, and north-eastern Quebec. The precipitation varied considerably in different parts. The Edmonton district of Alberta and parts of Manitoba, as well as the northern coast of the Pacific, received from 4 to 6 inches or more of rain, some regions in Quebec had more than 5 inches. In the maritime provinces the general average was less than 2 inches. On the southern coast line of Nova Scotia, moisture from abundant fogs mitigated to some extent the drought, where rivers and streams are said to be very low and wells are drying up. At the back of the *Weather Map* the highest and lowest temperatures and the precipitation, with brief comments on the weather and the state of the crops, are given for each station, the latter being of considerable interest generally.

THE first conference of the Pathological and Bacteriological Laboratory Assistants' Association was held on September 1-5, in the Department of Pathology of the University of Edinburgh. The attendance was exceedingly good, there being members present from all parts of Great Britain and also from Africa. The local organisation was in the hands of a committee appointed by the Scottish Division of the Association. Lectures and demonstrations in laboratory technique were held, an exhibition of laboratory work and apparatus was on view, and places of interest in and around Edinburgh were visited. Members of the Scottish Division of the Association were responsible for the exhibition, while the London Division showed objects of tropical interest and demonstrated specimens illustrating the life history of parasites and their insect hosts. At the dinner on Friday evening, September 5, the president, Prof. A. E. Boycott, made the presentation of the first Woodhead medal to Mr. Albert Norman together with an address. This medal has been established by means of funds collected among members of the Association in memory of the late Sir German Sims Woodhead. In all, 141*l*. has now been received and the subscription list is soon to be closed. According to the regulations governing the award which have now been drawn up, it is to consist of a prize and medal, the former being open to members of the Association only. Awards may be made annually or at longer intervals at the discretion of the Memorial Committee.

IT is stated in *Science* that Dr. E. S. Dana, emeritus professor of physics and curator of mineralogy at Yale University, has been elected a corresponding member of the Vienna Academy of Sciences

APPLICATIONS are invited from honours graduates in physics or electrical engineering for two junior assistantships in the National Physical Laboratory, Teddington. The necessary form of application may be had from the Director of the Laboratory, and returned to him not later than September 27.

THE autumn presidential address to the Radio Society of Great Britain will be delivered at 6 o'clock on Wednesday next, September 24, at the Institution of Electrical Engineers, by Prof. W. H Eccles, who will deal with the latest developments of the position of the scientific amateur under the Wireless Telegraphy Regulations.

THE twenty-first anniversary of the School Nature Study Union will be celebrated on Saturday, September 27, in the Common Rooms of the London Day Training College, Southampton Row, High Holborn. There will be a reception by the president, Dr. P. Chalmers Mitchell, and an address by Mr. G. H. Gater, Education Officer, London County Council. The general secretary of the Union is Mr. H. E. Turner, 1 Grosvenor Park, Camberwell, London, S.E.5.

APPLICATIONS are invited for appointments as temporary assistant chemists at the Government Laboratory. Candidates must possess the degree of B.Sc., with not less than second-class honours or equivalent, and should have, if possible, experience in investigative work. A form of application is obtainable from the Government Chemist, Clement's Inn Passage, W.C.2. The latest date for its return is September 30.

THE twenty-eighth autumn fungus foray of the British Mycological Society will be held at Bettws-y-Coed, N. Wales, on September 22-27. Mr. J. Ramsbottom will deliver his presidential address, entitled "The Taxonomy of Fungi," on September 24. Other papers to be read at the meeting are by Dr. Harold Wager on an aldehyde reaction in the tissues of fungi, and by Mr. A. W. Bartlett on a new species of Urophlyctis producing galls on *Lotus corniculatus*. Particulars of the foray can be obtained from the General Secretary of the Society, British Museum (Natural History), London, S.W.7.

THE Riga correspondent of the *Times*, in a message dated September 12, states that news had been received from Moscow announcing the arrival at Urga, Mongolia, of Mr. Roy Chapman Andrews, leader of the Third Asiatic Expedition of the American Museum of Natural History, who is seeking permission for the exploring and excavating work which it is proposed to carry out in 1925. This seems to dispose of the fears which were entertained in New York as to Mr. Andrews' safety. It was known there that he was on his way from Peking to Urga, and some anxiety was felt in view of the political disturbances which have been reported recently in Urga.

A LARGE individual of the loggerhead turtle, a tropical and sub-tropical species, was found alive near Dunvegan, Skye, on December 13, 1923. In recording its occurrence (*Scottish Naturalist*, 1924, p. 99) Dr. James Ritchie states that it measured 4 ft. 5 in. in length, weighed 309 lb., and was a female. It contained more than 1000 eggs, and is being mounted for exhibition in the Royal Scottish Museum, Edinburgh. Previous occurrences of the loggerhead turtle in Scotland date back to 1861, when two or perhaps three young specimens were found on the mainland about the same time; a small individual, recently dead, was washed up on North Uist in 1898.

THE British Research Association for the Woollen and Worsted Industries announces the following awards for the year 1924–25: Research fellowships to Mr. R. Burgess, of Nottingham, to enable him to continue his research at the University College, Nottingham, on the bacteriology and mycology of wool; and to Mr. J. E. Nichols, of Edinburgh, to conduct research at the Animal Breeding Research Department of the University of Edinburgh on the relationships between the wool fibres of various breeds of sheep: an advanced scholarship to Mr. H. Maldwyn Williams, tenable at the Scottish Woollen Technical College, Galashiels.

THE following awards for the year 1924–25 have been made by the Salters' Institute of Industrial Chemistry and approved by the Court of the Company:—Fellowships are renewed to Dr. W. G. Sedgwick, Armstrong College, Newcastle-on-Tyne, and Oxford, Fellow, 1923–24, and to Mr. W. Randerson,

Imperial College of Science and Technology, Fellow, 1922–23, and Hon. Fellow, 1923–24 (during tenure of Albert Kahn Travelling Fellowship). Fellowships are awarded to Mr. H. H Evers, University of Liverpool; Mr. K. Knight Law, University College, Nottingham; Mr. H S. Pink, University College, Nottingham, and Oxford; and Mr. V. E Yarsley, Birmingham University. The Salters' Institute has also awarded seventy-two grants in aid to young men and women, employed in chemical works in and near London, to facilitate their future studies.

DURING the forthcoming winter, Mr. H. V. Garner, the guide demonstrator of the Rothamsted Experimental Station, Harpenden, will be available for lectures to Chambers of Agriculture and Horticulture, Farmers' Clubs, Agricultural Societies, etc., on the Rothamsted experiments in regard to the manuring of various crops, the management of farmyard manure, and on chalking and liming. For Students' Societies and similar bodies, lectures could be arranged dealing with the field and laboratory work at Rothamsted. No fee is charged for Mr. Garner's services, but any association engaging him would be expected to defray travelling expenses All communications regarding lectures should be addressed to the Secretary, Rothamsted Experimental Station, Harpenden.

THE next meeting of the American Association for the Advancement of Science is to be held at Washington on December 29–January 3, and local committees have been appointed. Great efforts are being made to deal with the question of wide publicity for the meeting. Authors of papers are being asked to prepare abstracts of their contributions, and Science Service is again to co-operate with the Association's publicity committee in preparing material for the Press. The meeting will open with the address of the retiring president, Dr. C. D. Walcott, and it is hoped that the President of the United States will also address the Association and the associated societies. Another general meeting will be held on December 31, when Prof. A. S Eddington will speak on "Relativity." In connexion with the meeting, an exhibition of scientific apparatus, methods, books, and products is being arranged as in previous years. Reduced railway fares have been arranged for members of the Association travelling to Washington from any part of the United States, or from places in Canada east of and including Armstrong, Fort William, and Sault Ste. Marie, Ont

A DIRECTOR of research is required for the Forest Products Research Laboratories of the Department of Scientific and Industrial Research which are being provided to deal with pure and applied scientific research called for by the practical needs of the using industries and departments of state. The researches will be specially concerned with home-grown and Empire-grown timbers and other forest products. Candidates should possess good scientific qualifications, and a broad experience of the origin and use of forest products. Width of knowledge in forest economy, in the technology and practical problems of the wood-using industries, and in the bearing on these problems of scientific and industrial research, is considered of first importance. The latest date for the receipt of applications (which should be sent to the secretary of the department, 16 Old Queen Street, Westminster, S.W.1) is December 1.

Our Astronomical Column.

MERCURY A MORNING STAR.—Mercury will reach its greatest elongation west (17° 52′) on September 27 and be favourably visible as a morning star. The planet may be seen shining over the eastern horizon about an hour before sunrise. Its position will be in Leo, about 28° E.N.E. of the brilliant planet Venus. On the day of its elongation the planet will rise at $4^h\ 12^m$ A.M., G.M.T., or $1^h\ 43^m$ before the sun.

Apart from the morning stars—Mercury and Venus—the zodiacal light will be strongly visible on clear mornings towards the end of September and the beginning of October, when the moon will not offer any impediment to observation.

STUDIES OF ALGOL VARIABLES.—Studies of the details of the light-curves of these variables, combined with spectroscopic measures of their radial velocities, are of importance from the information they give about stellar masses, diameters, and the degree of darkening of their limbs from atmospheric absorption. Mr R. S. Dugan is undertaking an extensive investigation of their light-curves by photography at Princeton University Observatory. No. 6 of the Contributions of the Observatory contains researches on five variables. SZ Herculis is interesting from the slight degree of limb-darkening, the slight loss of light at secondary minimum, and the considerable masses, 4·6 and 1·4 of the sun, the spectral types being B8, B9. R Canis Majoris is the only naked-eye star among the five, its normal light being 5·3 mag., and the loss of light at primary and secondary minimum, 0·56 and 0·06 respectively. The masses are small: assuming a mass-ratio of 3 to 1, they are 0·14 and 0·05 of the sun; the spectral type of the primary is FO Two of the five stars, Y Camelop and RY Aquarii, give indications of limb-darkening. The most conspicuous loss of light at secondary minimum is that of SZ Herculis, 0·24 mag., as compared with 1·83 at primary minimum.

ENCKE'S COMET.—Several photographic positions of this comet were obtained in August by Mr. G. Merton with the 30-inch reflector at Greenwich. They indicate that the date of perihelion will be close to Oct. 31·437 G.M.T., which is 0·008 day later than that predicted by L. Matkiewicz. The comet should be an easy telescopic object at the end of September. The following ephemeris by Matkiewicz is for Greenwich noon.

	R A.			N. Decl.		log r.	log Δ.
Sept. 21.	8^h	1^m	32^s	35°	12′		
,, 23.	8	20	52	34	12	9·9699	9·8918
,, 25.	8	40	25	32	57		
,, 27.	8	59	58	31	28	9·9372	9·8810
,, 29.	9	19	21	29	46		
Oct. 1.	9	38	23	27	51	9·9004	9·8782
,, 3.	9	56	54	25	44		

Research Items.

ABORIGINES OF THE MALAY PENINSULA.—In vol. xii, pt. 1 of the Journal of the Federated Malay States Museums, Mr. Ivor H. N. Evans gives an account of an expedition to Mt. Gunong Benom, Pahang, undertaken in March and April 1923 for the purpose of verifying a statement made by Wilkinson in the 1911 Census Report that " the wild tribes on Gunong Benom spoke a distinct dialect of their own . . . and it is not possible at present to say whether this distinction is accompanied by any racial or cultural differences." As a result of his investigations, Mr. Evans is doubtful whether the census enumerators visited the mountain or induced the inhabitants to come down from it. He himself was unable to find any traces of aborigines or of their occupation, and, with the exception of two Sakai-Jakun, no aborigines were found on the western side. On the way down to Kuala Krau an aboriginal settlement was reached at Galong, near Kuala Krau, and the inhabitants there, who were Jakun speaking a Sakai dialect, informed him that there were no aborigines on Gunong Benom, though Negritos (Batek) of Ulu Cheka visited it to collect Ipoh poison. Mr. Evans also obtained information of two divisions of aborigines on the Lompat river, of whom one, the So-ben, is very wild, lives in shelters, does not cultivate the soil, and uses stone knives for cutting and splitting wood.

THE ART OF THE PAL EMPIRE IN BENGAL.—In a communication to the Royal Society of Arts which is published in the Society's Journal of August 22, Mr. J. C. French points out that the mounds which mark its buried cities and its art are the only relics we possess of the Pal dynasty. This dynasty reigned in Bengal from the eighth to the eleventh centuries of our era, when it was overthrown by the Sena dynasty —an event which marked the decline of Buddhism and the establishment of a new caste system. The rise of the Pal dynasty with the first king Gopala, described as " sea-born," ended a period of anarchy. The art of this early period was marked by simplicity, dignity, and an immanent sense of life and vitality. In the succeeding reign of Devapala flourished Dhiman and his son Bitpala, the only two artists whose names have been preserved. They founded the Eastern School and the School of Magadha respectively. Early in the eleventh century, Pal art had reached its zenith and began to show signs of decline in its more florid style In the orthodox Brahmanical period which succeeds the Pal dynasty, the art is harder, stiffer, and more conventional, with over-elaborated decoration. The inspiration of the artistic representation of orthodox Hindu deities in the earlier period would appear to be derived from Buddhism and to have declined with it. The importance of the art of the Pal Empire, notwithstanding its local character, lay in its influence on other, and also on later schools of Indian art

THE BRACHYCEPHALIC SKULL —Prof. F. G. Parsons has published the results of his study of the brachycephalic skull by means of dioptographic sketches and by the method of reduction of a series to composite sketches from three points of view, together with the detailed measurements, in the Journal of the Royal Anthropological Institute, vol. 54, Pt. 1 It would appear that the length of the dolichocephalic skull depends upon increased growth in its posterior part, while the greater breadth of the brachycephalic skull is due to growth in its temporal regions. The short European skull is usually more prognathous than the dolichocephalic skull. It is also more broad-nosed, and its orbital height is not so great when compared with the whole area of the face. Both as regards width and height, the orbital measurement would appear to be of considerable racial importance ; in the Nordic race the orbit is very high, while in both the Mediterranean and the Long Barrow races it is very low. In the brachycephals it comes between, but is closer to the Long Barrow race than to the Nordic.

THE GREAT BARRIER REEF —The first report of the Great Barrier Reef Committee of the Royal Geographical Society of Australasia is published in the Queensland *Geographical Journal* (vol. xxxviii.). The work of investigation included in this report was mainly of a general nature, but it indicates some of the problems which it is hoped to solve Attention was particularly devoted to those parts of the reef between Cairns and Thursday Island. Attention paid to the form and size of cays and reefs fully confirmed previous ideas as to the influence of the prevailing south-east wind in developing the forms of coral debris along stream lines more or less parallel to the direction of the wind. Observation did not confirm the contention of Agassiz that " nigger heads " are proof of recent elevation. It appears more likely that the occurrence of these masses of coral is due to the action of hurricanes which tear off portions of the growing reef and wash them to leeward. Another problem of great interest is the origin of the openings through the outer Barrier. The committee discards the theory that these openings mark old entrances to the sea of the present coastal rivers. The evidence rather points to their being coastal valleys of the foundered strip on the edge of which now exists the Great Barrier Reef, although many of the drowned valleys have been silted up to a considerable extent. The sediment from the coastal streams being deposited in the depths of the drowned regions, prevents coral growth in these areas.

GEOCHEMICAL DISTRIBUTION OF THE ELEMENTS.—The distribution of the elements in the earth, considered from the geochemical point of view, is the subject of a series of three papers issued recently by Prof. V. M. Goldschmidt, of Christiania, under the title " Geochemische Verteilungsgesetze der Elemente " (Videnskapsselskapets Skrifter, I., Mat-Naturv. Klasse ; 1923, No. 3 ; 1924, Nos 4 and 5.) He regards the earth as having been originally gaseous or molten. On cooling, it passed through a stage in which there were three fluid phases consisting of metal, sulphide and silicate. These three different kinds of molten material separated according to gravity, giving a concentric arrangement, with the metal at the core, next a shell of sulphide matter, and outside this a shell of silicate, around which there was a cover of vapour and gas. The silicate shell separated by crystallisation into heavier and lighter parts, gases escaping from it in the process. In accordance with this supposed differentiation of the materials of the earth into four phases during the process of cooling, he divides the chemical elements into four corresponding main groups, namely, (1) siderophils (Fe, Ni, Co, P, C, Mo, Pt, etc) ; (2) chalcophils (S, Fe, Cu, Zn, Cd, Pb, As, Sb, Bi, Ag, Au, Hg, Pd, etc.), (3) lithophils (O, Si, Ti, Zr, Th, F, Cl, Br, I, B, Al, Y, La, Ce, Li, Na, K, Be, Mg, Ca, Sr, Ba, V, Cr, Mn, Nb, W, Sn, etc.) ; and (4) atmophils (H, N, He, Ne, A, etc.). A further separation of the elements is effected by later differentiation in the lithosphere, during the course of which any residual chalcophils aggregate as sulphide deposits, while

residual atmophils find their way into the atmosphere. According to their isomorphic relationships with the commoner lithophils, the rarer lithophils can be divided into three sub-groups, namely, (1) elements of the first crystallisation, isomorphic with trivalent iron and magnesium, *e.g.* chromium, vanadium, and nickel; (2) elements of the chief crystallisation, isomorphic with potassium, calcium and aluminium, *e g.* rubidium, strontium and in part scandium; (3) elements of the residual crystallisation, which are non-isomorphic or only weakly isomorphic with the commoner lithophils, *e.g.* lithium in part, boron, niobium, thorium and lanthanum. In the second paper Prof. Goldschmidt deals with the geochemical distribution of the elements in relation to the structure of the atom, while in the third paper he deals with the distribution of the rare-earth metals among minerals.

WEATHER IN WEST INDIES.—A summary of the weather in the West Indies and surrounding neighbourhood for 1923, prepared by Mr. Oliver L. Fassig, Meteorologist in Charge, has recently been published under the superintendence of the Weather Bureau of the U.S. Department of Agriculture. The rainfall was generally deficient, and the annual total was between 25 and 35 per cent. below the normal in Jamaica, Santo Domingo, and Porto Rico of the Greater Antilles, and Dominica and Martinique of the Lesser Antilles. In Porto Rico the total for 1923, 51·63 in, was the smallest recorded in the past 25 years. Rainfall was continuously below normal, over the section as a whole, from January to September and in November. For the three consecutive years—1921, 1922, and 1923—the aggregate deficiencies in rainfall for the area as a whole amounted to 40 inches, and rainfall above the normal was recorded only in 8 months out of 36. Although 1923 was exceptionally dry, October was conspicuous for the frequency of torrential rains. Temperatures during the year were generally slightly above the normal for the area as a whole. The region of the West Indies and Caribbean Sea was remarkably free from cyclonic disturbances. A few errors have crept in, and among those noticed are the statement in the general summary, p. 97, that the October temperature was below the normal; the month clearly should be April. On p. 105 the sea-water temperature at Balbao in the Panama Canal Zone for August is given as 93·1° F., which is clearly 10° too high, and the March temperature given as 69·3° is presumably 10° too low. Monthly Reports are regularly published, based on a large number of observations These contain, in addition to the ordinary meteorological observations, details of earthquakes which are not summarised in the Annual Report.

INSECTAN PALÆONTOLOGY.—Entomologists have been following with keen interest Dr. R. J. Tillyard's series of papers on the Mesozoic Insects of Queensland, appearing since 1916 in the Proceedings of the Linnean Society of New South Wales. In his latest contribution to the subject (*l.c.* xlvii. pt. 4) Dr. Tillyard describes further insect remains from the Upper Trias of Ipswich, Queensland. These include a Protorthopteron apparently allied to members of the Upper Carboniferous fauna of Europe, as well as several species of Orthoptera, Odonata, Hemiptera, Neuroptera, and Coleoptera. Among the Hemiptera, both Homoptera and Heteroptera are included, the most noteworthy discovery being a new genus, Triassocoris, belonging to the Cryptocerata—that section of the bugs which comprises our familiar Nepa (water-scorpion) and Notonecta (water-boatman), as well as the large tropical Belostomatidæ to which Triassocoris, though smaller, is nearly allied. In another paper (*l c.* pt. 3) Dr. Tillyard describes some Permian insects collected at Belmont, New South Wales, by Mr. J. Mitchell. These fossils are of very great importance, as they prove that the late Palæozoic Australian insect fauna included metabolic insects belonging to the living orders of the Mecoptera and the Neuroptera Planipennia, as well as to the extinct Paramecoptera. Dr. Tillyard suggests that this ancient assemblage of insects was part of "a fauna developed in association with the fern *Glossopteris*, in which primitive scorpion-flies took the place of the cockroaches dominant in the Carboniferous and Permian of the Northern Hemisphere." He comments on the comparatively high organisation of these oldest known Australian insects, believing that they immigrated into that region long after the more primitive types had been established in the European area. Two recent short papers by Dr. Tillyard are of interest on account of the remarkable conditions under which the insect-wings described were found. A long-horn grasshopper, probably of late Tertiary age, is represented by a wing-fragment embedded in a large crystal of selenite, enclosed in the actual copper lode worked by the Mount Elliott mine, North Queensland (*Rec. Geol. Soc. N.S. Wales*, x. pt. 2). A new genus of dragon-fly is described (*Geol. Mag.* lx., 1923, No. 706) from wing-fragments discovered by Mr. R. May, of Cambridge, in the matrix of the shell-cavity of an ammonite of Upper Jurassic (Corallian) age, which, washed out of its proper bed, was found in the Boulder Clay of Hertfordshire.

MECHANISM OF PHOTOSYNTHESIS.—Jaroslav Peklo (*Chem. News*, 129, 1924, pp. 91-94) recently advocates the adoption of Willstätter's scheme as to the rôle of catalase in photosynthesis The arguments are based on the effect of potassium cyanide on the rate of liberation of oxygen in photosynthesis. This substance (and also hydrogen sulphide and phenylhydrazine) exerts a paralysing effect on catalase action, but not on all other enzyme reactions. The immediate stoppage of photosynthesis on treatment with potassium cyanide is therefore held to show that catalase takes some intimate part in photosynthesis and hence to prove that Willstätter's view is correct.

FRUIT PRODUCTION IN CACAO.—In the *Tropical Agriculturist* (lxiii., 1924, pp. 22-26), Prof. S. C. Harland outlines the results of some interesting experiments in Trinidad on the fruit yield of vegetatively propagated cacao plants. A striking feature of the results is the fact that there is no connexion between the average yield of the parent plants and that of their budded offspring. Thus the practice of taking buds from parents of high fruit-setting power apparently has no experimental justification. The author points out that this result is probably paralleled by similar experiments on apple, cotton, and rubber, and he suggests that the ultimate yield of the budded tree must depend not only on the quality of the buds but also on that of the stock on which they have been incorporated.

A HIGH VACUUM PUMP.—Report No. 62 of the Research Department, Woolwich, emanates from the Radiological Section and describes a new glass mercury condensation pump for the production of high vacua, designed by Dr Gilbert West, which has been in use in the Department for some time and is easy to make and clean. The mercury is contained in a glass flask with a long neck, which is kept cool by a water jacket surrounding it. The upper end of the neck is connected to the auxiliary pump, which provides a pressure between an eighth and a thousandth of an atmosphere. A side tube enters the neck

at the lower end of the cooled portion and is bent upwards so as to be within the cooling water jacket. The upper end of this tube is connected to the vessel to be evacuated. The mercury is heated to about 150° C., at which it has been found the pump as designed gives the best results. The vacua obtainable are only limited by the evolution of gas from the walls of the vessels evacuated, and the rate of evacuation is high.

METALLURGICAL MICROSCOPES.—A new catalogue and price list of metallurgical microscopes, outfits, and accessories has recently been issued by Messrs. James Swift and Son, Ltd., of 81 Tottenham Court Road, London, W.1. The microscopes described have been designed specially for metallurgical work, and include the well-known Jackson-Blount model and the Inverted Metallurgical Microscope. In the latter, the design of which is due to Le Chatelier, the objective points upwards and is immediately below the stage on which the specimen is placed. By reason of this design, the necessity for grinding the object parallel or mounting it in wax or using a levelling stage is obviated. The present model is provided with a commodious stage and improved focussing adjustments. The illuminator fitted to both these types of microscopes has a reflector which can be adjusted in and out across the optic axis and can also be tilted simultaneously in two azimuths at right angles to each other, thus allowing efficient and uniform illumination to be obtained. The instruments, optical equipment, and accessories included in the catalogue cover the full needs of the metallurgical microscopist engaged either in regular routine work or in original research.

ELECTRICAL CONDUCTIVITY AND BOHR'S THEORY OF ATOMIC STRUCTURE.—The maximum conductivity of the elements occurs, according to Vegard, when a new electron is added to the structure in a new orbit Herr O. Feussner, in the *Zeitschrift fur Physik*, July 12, gives a table showing the probable electronic structure of elements which are not included in that of Bohr, and compares the combined tables with the graph showing the connexion of conductivity with atomic number. Maxima are found in the case of the alkali metals, including cæsium and rubidium, in which a single electron circulates in the highest orbit group, and the configuration of the inner electrons is that of the preceding inert gas; there are also maxima for Cu, Ag, and Au; the relation between the electron orbits of Cu and the preceding element Ni is assumed to be as follows:

	1_1	$2_1 2_2$	$3_1 3_2 3_3$	4_1
28 Ni	2	4 4	6 6 6	—
29 Cu	2	4 4	6 6 6	1

or very similar to that between the orbits of potassium and argon; a similar relation holds between Ag and Au and the metals which precede them in the table. It is true that the same relation holds for Co and the preceding element Fe, though Co does not show a relative maximum of conductivity. Vanadium is an example of an element with one electron in a 4_1 orbit, which does not show a maximum; it has 12 electrons in the *M* group, while titanium, the preceding element, has 10, and two in the *N* group (4_1); such elements show no maximum. Cr, Mo, and W have relative maxima, though the most probable number of electrons in the orbit group with highest principal quantum number *n* is two. It has been suggested that an examination of the spark spectrum of Cr would decide whether there are one or two electrons in the *M* group.

EVIDENCE OF INTRA-ATOMIC FIELDS IN SPECTRA.—The effect of strong electric and magnetic fields on the mercury spectrum has recently been described in a paper by Messrs. Hansen, Takamine, and Werner (Det Kgl. Danske Viden. Sels., Math.-Fys. Medd. v. 3). The primary object of the investigation was to see if the lines, $1S - 2p_1$ and $1S - 2p_3$, which are forbidden by the selection principle, could be produced under magnetic or electric influence. It was found that while the former was excited in considerable intensity by condensed discharge, the latter could not be produced at all. The general effect of the electric field was the production of new combination lines, of which the relative intensities, state of polarisation, and displacements in the fields were measured. The general features of the effects were in close agreement with the quantum theory of spectra. Some time ago Dingle pointed out that the spectrum of the flame-arc of mercury in vacuum contained lines of the type $2p - mp$, which are disallowed by the selection principle, and Takamine, in a further paper (*Japanese Journal of Physics*, vol. ii., Nos. 3-5), surmising that the explanation lay in the close gathering of the atoms in the narrow flame so that the intra-atomic electric fields came into play, describes further experiments with a vacuum arc provided with a constriction. The spectra of mercury, zinc, cadmium and thallium were examined. It was found that, at the constriction, many lines normally forbidden by the selection principle were produced. The similarity between the broadening of the lines at the constriction and that produced in the Stark effect led to the conclusion that the appearance of the forbidden lines was actually a Stark effect due to the intra-molecular electric field coming from the close gathering of ions and electrons at the constriction.

THE IRON SPECTRUM—In the *Japanese Journal of Physics*, vol. ii., Nos. 1-2, Messrs. Nagaoka and Sugiura describe some interesting investigations of the iron spectrum, made with the view of detecting regularities in the arrangement of the lines. The lines were sorted into groups by observing their behaviour in an electric field, the simplest of the effects thus produced being "the enhancement of lines with small displacement towards shorter wavelengths." Lines affected in this way were found to form triplets, quartets, sextets, and sometimes more complex groupings, all of which were similar to the Zeeman patterns ordinarily formed by the components of single lines when produced in a magnetic field. This suggested that the lines were actually Zeeman components, produced by the strong intra-atomic magnetic fields of the atoms. The separations in the groups—which varied, in groups of the same type, over a considerable range—amounted in some instances to several hundred units of wave number. For example, there are six quadruplets in which a separation having a mean value of 362·9 occurs: the individual separations range from 354 to 372. From the ordinary expression, $\Delta\nu/H = 4{\cdot}7 \times 10^{-5}$ gauss^{-1} cm.$^{-1}$, this gives, on the assumption mentioned, an intra-atomic field of 7×10^6 gauss—in close agreement with the value deduced by Weiss from his experiments on the magnetic quality of iron at high temperatures. One difficulty facing the hypothesis is the fact that the lines in question are themselves decomposed by an external magnetic field, whereas they would be expected to be merely displaced if they were already magnetically produced components of lines. It is remarked also that sometimes one and the same line enters into several different groups. The authors suggest that the intricate nature of the spectral lines of ferro-magnetic metals may ultimately be traced to the existence of intra-atomic fields.

Food Preservatives and their Action.

UNDER modern conditions of civilisation, the question of supplying food to large numbers of people who live at a distance from the actual areas of production, has assumed an importance which can scarcely be overestimated. The problem has been attacked along two lines: first, by means of quicker and more efficient transport; secondly, by the introduction of preserved foods, including under this term both those which are sterilised by heat and also those preserved by exposure to low temperatures. Owing to the loss or partial destruction of certain accessory food factors during the process of preservation, it is essential that fresh food, especially vegetables and fruit, should be available for general use, and this is largely ensured by means of efficient transport between producer and consumer. On the other hand, certain articles of diet, especially meats, which must be transported long distances, must undergo some treatment to keep them in a condition fit for human consumption, and there is no doubt that the most suitable method to employ is one which ensures sterility and its maintenance during transport: thus the meat, after *efficient* sterilisation by heat, may be tinned and kept sealed from the air, or it may be chilled or frozen, the low temperature preventing any microbic or similar growth.

Unfortunately, simple chilling of meat at a temperature just below freezing point will not prevent deterioration on a long voyage: freezing at a temperature of 10° F. is, however, successful, but the meat does not compare so favourably with fresh meat It has, therefore, been suggested that the process of chilling might be supplemented by the addition of a chemical preservative or antiseptic when meat has to be conveyed long distances before consumption. The substance which has been used commercially to a small extent in this connexion has been formaldehyde, and the question at once arises as to the effect of this substance upon the human economy. In the Interim Report of the Food Preservatives Committee,[1] recently published, the use of formaldehyde as a food preservative is considered, both from a general point of view and also with particular reference to the carriage of chilled beef. The Committee is unanimous in condemning its use, both with regard to its effects on the consumer himself and also from the fact that it can be used to conceal incipient decomposition, without, of course, thereby rendering the food fit for human consumption.

Formaldehyde acts as an antiseptic since it is a powerful protoplasmic poison: its action is, however, not specific for micro-organisms only, but it also reacts with human tissues, combining with the proteins: thus its excretion is slow and so its action is probably cumulative. When ingested it irritates the mucous membranes with which it comes in contact, and after prolonged use may cause inflammation of the liver and kidneys. It also combines with the proteins of foods, thus rendering them less digestible. In spite of these drawbacks, its use might perhaps have been thought less objectionable in the case of chilled meat, where the carcasses, after being placed in the refrigerating chamber, are exposed for a short time only to the action of the formaldehyde in the form of vapour; the air in the chamber is circulated by fans, and after about half an hour the vapour is removed by a current of fresh air.

In these circumstances it might have been supposed that any organisms on the surface of the carcasses would be killed and the meat remain fresh at a temperature just below the freezing point. Apart from the fact that the process is uncertain in its action owing to the uneven distribution of the vapour in the chamber, its success also seems to depend on the cleanliness with which the meat is handled before it is put into the chamber. These considerations tell against the method, and when it is also found that traces of formaldehyde may be present in the meat at more than one inch from the surface, it is seen that the consumer may take into his system quantities of the poison which cannot fail, in the long run at any rate, to be injurious.

The Committee concludes, therefore, that formaldehyde should be banned as a food preservative in all cases This conclusion may be applied also to the use of formaldehyde as an antiseptic in disease. For external application it has its use, but internally any effect it may have upon micro-organisms is counteracted by its simultaneous deleterious actions upon the tissues of the body.

[1] Interim Report of the Food Preservatives Committee on the Treatment of Chilled Beef and other Foods with Formaldehyde. (Ministry of Health.) H.M. Stationery Office, 1924. Price 2*d*

The Free Atmosphere in India.[1]

THE Memoirs before us are by Mr. J. H. Field, who has succeeded Sir Gilbert Walker at Simla, and by Dr. W. A. Harwood. They are of particular interest from the fact that both authors have been connected with upper-air work in England almost from its first conception.

In the introduction, Mr. Field discusses the methods and instruments that were used, many of which were designed by him especially for the purpose; and he is to be congratulated on the success that has been attained.

Owing to the climate of India the ordinary rubber balloons could not be used, on account of the difficulty of storage, and gutta-percha balloons, made up as required, were substituted for them. Mr. Field describes his semi-graphical methods of working up theodolite observations quickly, and gives some very useful formulæ showing the final error in terms of the errors of observation. He finds that too much trust may easily be placed in the two-theodolite method, and gives an example in which the four angular measurements are perfectly consistent among themselves and yet the height of the balloon is in error by 50 per cent. He adopted the tail method for general use.

The results of some very useful experiments are given, showing the extent of the errors which may occur owing to the heating by solar radiation of the recording instruments, and also by the inevitable lag of the thermograph. The conclusion reached is that the resulting error is small up to a height of six kilometres, and this is confirmed by the good agreement of the mean values obtained by night and by day. Above 10 kilometres the error is increased by the unfortunate necessity in having to use gutta-percha balloons, the rising velocity of which falls off as their highest point is reached; but up to 12 kilometres it does not seem likely that the error exceeds two or three degrees.

Mr. Field has done a most useful piece of work,

[1] "Memoirs of the Indian Meteorological Department." Vol. xxiv., Parts v., vi., vii., and viii.

and his memoir should be read and carefully studied by every one similarly engaged: to such it will give many valuable hints.

In Part vi. Dr. Harwood discusses the observations made with kites and registering-balloons over India and the Arabian Sea. He gives first a summary of the results obtained by Field by means of kites, and then deals with the registering-balloon ascents made in India, chiefly at Agra, during the years 1914–18. In all 237 were sent up, 156 instruments were returned, and 152 of these gave usable records, a result which reflects great credit on Mr. Field and his Indian assistants. The figures were handed to Dr. Harwood, on his return from war service in 1918, to be worked up.

Dr. Harwood has taken every care to ensure accuracy, and being well acquainted with the many possible sources of error, has only used such ascents as may be reasonably supposed to be free from error, especially from the effects of solar radiation, a precaution needful in view of the slow rise of gutta-percha balloons. He gives particulars of the temperature, humidity, and pressure at various heights in the three Indian seasons—the cool, the hot, and in the monsoon—and also annual means for the density. He carries his tables up to 12 kilometres, and it is only to be regretted that the stratosphere was not reached, and that at least the results from Agra are not published in full detail.

It is not possible to comment on the many interesting points discussed, but the following may be mentioned. The mean annual lapse rate comes out as identical up to 9 kilometres with that of nearly all other stations; so also the daily temperature variation in India, as elsewhere, is confined to the first one or two kilometres The excessive heat of the hot season is found to be confined to the bottom layer; higher up the monsoon season is the hottest. The high correlation between pressure and temperature so noticeable in Europe is absent in India, perhaps because the short period variations of pressure are too small.

Comment is made on the figures for the equator given by the reviewer in the M.O. Geophysical Memoir, No. 13, and the absence of information as to their source. These figures were formed from the smoothed mean values derived from the few data available at that time. Further observations on the equator are necessary to show whether Van Bemmelen's excellent set of results from Batavia, most of which have been published since then, fairly represent the general equatorial conditions.

Parts vii. and viii. discuss the motion of the free air over India as it is observed by means of clouds and pilot balloons. The year is divided into three seasons, and three separate heights are taken: the height of low clouds, 2 kilometres; of middle clouds, 5 kilometres; and of high clouds, 9 kilometres. These are the heights assigned to the different clouds in the International Cloud Atlas, and Dr. Harwood accepts them as correct for India. Many tables are given showing the direction of the wind and the percentage frequencies for each direction at each height for 15 stations distributed over the Peninsula; in some cases separate values for each month are given. It is noted that cloud observations necessarily refer to cloudy weather and that pilot-balloon observations will refer chiefly to clear weather, and there is some evidence that there is a systematic difference between the two, but it does not seem to be large enough seriously to prejudice the results of using them as equivalent. The figures will be of great interest to any one who is endeavouring to elucidate the cause of the monsoons.

In Part viii. the relation of the monsoons to the general circulation of the atmosphere is dealt with, and the similarity of the north-east monsoon to the circulation over the North Atlantic is discussed. Dr. Harwood finds a very noticeable coincidence between the track of storms and depressions, as shown in the Climatological Atlas of India and in the Meteorological Atlas of the Indian Seas, and the monthly mean directions of the upper winds at the cirrus level. If this be more than a coincidence, and it seems to be so, it has an important bearing on the formation and propagation of cyclones, and shows that their source must be sought for in the upper winds rather than in the surface conditions.

The four Memoirs form a very valuable contribution, not to Indian meteorology only, but also to meteorology in general. W. H. DINES.

The Royal Photographic Society's Annual Exhibition.

THE Royal Photographic Society's Exhibition was opened on Monday, September 15, and will remain open until October 25, with free admission, at 35 Russell Square. The Scientific and Technical Section is probably the largest and in a general sense the most interesting that the Society has ever been able to arrange. Among the astronomical exhibits are photographs of nebulæ made at the Mount Wilson Observatory by the 60-inch and the 100-inch reflecting telescopes, illustrating Dr. Edwin Hubble's proposed general classification of nebulæ, and a frame that shows the different degrees of elongation of elliptical nebulæ. Dr. William J. S Lockyer, director of the Norman Lockyer Observatory, Sidmouth, sends some striking photographs of star spectra, and what is, with little doubt, the most successful photograph of a meteor that has ever been secured. Various forms of clouds and their changes are illustrated by several contributors, and geological work by one exhibit from the National Geographic Society of Washington. Closely allied to this are several "survey and record" photographs from the United States and Canada, a very notable one being a photograph, by Dr. W. H. Wright of the Lick Observatory, of the Sierra Nevada Mountains in the neighbourhood of the Yosemite Valley, taken from the Observatory on Mount Hamilton. The details shown range in distance up to 135 miles, and several comparative details are indicated which clearly demonstrate the effect of the curvature of the earth in depressing the more distant as compared with the nearer hills.

Among the stereoscopic slides, the set of 50 by Mr. Herbert G Ponting which illustrate China and Japan, and include the manners, customs, and occupations of the people, are specially notable. The new Section of Cinematography has twenty excellent exhibits by three authors. Press photography, commercial stage photography, lantern slides, colour photographs of many kinds, natural history photographs, radiographs (including the C.D.X. dental X-ray apparatus of Messrs. Watson and Sons, and a series of 18 dental radiographs), photographs transmitted by wireless, and so on, are all shown in their latest and most perfect forms.

Photomicrography in the service of technology and scientific investigation is exceptionally well illustrated. The Research Laboratory of the Eastman Kodak Co. shows the fibres, and their characteristics, that are contained in photographic paper pulp, and illustrate a new method of distinguishing rag and bleached wood pulp, presumably by differential staining and photographing through suitable colour screens. Mr W. S. Gerecke, of the U.S. Rubber Co., has sent a long series that refer to

the manufacture of india-rubber and the changes that it is liable to The British Photographic Research Association shows some of its latest results. Results obtained by the " Davon super-microscope," which has given rise to so much discussion of late, are illustrated by several photomicrographs by Mr. J. D. Jacobs, ranging in magnification from 1000 to 4000 diameters, each with a statement of the optical means employed.

Mr. P. P Quayle, of the Bureau of Standards, Washington, shows a series of six photographs of the phenomena at the muzzle of a 0·45 calibre revolver when it is fired, taken by an apparatus that gives no evidence whatever of its presence in the pictures. A very interesting method of determining the effect of various conditions, such as stirring, changes of temperature, and so on, on reaction velocity by utilising the decay of luminescence in the Japanese ostracod, *Cypridina hilgendorfii*, is illustrated and explained by Dr. William R. Amberson. The " Mutochrome," invented by Mr. C. F. Smith, of Messrs. Adam Hilger, Ltd., is shown in action. By its means any pattern or design may be photographed and then projected full size upon a screen with the possibility of varying almost infinitely the colour and depth of tint of the various elements.

In concluding this necessarily incomplete account of the scientific part of the Exhibition, we wish to point out that in the prospectus this section is divided into eight well-defined sub-sections, each with its separate board of judges, and to ask, for the sake of students, that each of these divisions may be as clearly separated and indicated, in future, in the Exhibition itself. As it is, there is much confusion. According to the Catalogue, " Technical Applications " are scattered in eleven different places; some " Astronomical Photographs " are under this heading and some are under " Technical Applications," and so on. We would also add that it is very pleasing to see so rich a collection of work from the United States, and to be able to remark on the very high standard of excellence of all the exhibits.

University and Educational Intelligence.

LONDON.—H.R.H. Prince Arthur of Connaught has consented to undertake in November the formal opening of the Ramsay Laboratory of Chemical Engineering at University College, instituted in 1923 as part of the Memorial to the late Sir William Ramsay. A full course of study in chemical engineering will be provided in the laboratory in the coming session, leading to the degrees of M.Sc or Ph.D. in chemical engineering. The course is designed to meet the demands of the manufacturing industries for men trained in the application of scientific methods to the design and operation of industrial chemical processes and plant. Special facilities are provided for research. Particulars can be obtained from the Secretary of the College.

SHEFFIELD.—The Council of the British Cast Iron Research Association has appointed Mr. J. G. A. Skerl to take charge of an investigation on moulding sands, to be carried out in the Refractories Department of the University and in the foundries of members of the Association. Mr. Skerl has for nearly three years been research assistant to Prof P. G. H. Boswell, of the University of Liverpool.

APPLICATIONS are invited, from Egyptians only, for a whole-time lectureship in chemistry at the School of Medicine, Cairo. The applications, with particulars of qualifications, research work, etc., should be sent to reach the Director of the School before October 10.

A DEMONSTRATOR in metallography and pyrometry is required in the metallurgical department of the Royal School of Mines, Imperial College of Science and Technology, South Kensington. Particulars of the duties of the post can be obtained from the secretary. The latest date for applications is September 27.

APPLICATIONS are invited by the Harper Adams Agricultural College, Newport, Salop, for an Advisory Economist and an Advisory Chemist for service in Shropshire, Staffordshire, and Warwickshire. Candidates must hold a degree of a British university and should have, if possible, some agricultural experience. Applications, with copies of three recent testimonials, must reach the principal of the College not later than September 30.

DR. RUDOLF STEINER delivered a public lecture on education on August 30 in London, under the auspices of the Educational Union for the Realisation of Spiritual Values, the chair being taken by Miss Margaret Macmillan. He gave an exposition of his work as director of the Waldorf School at Stuttgart, where his theories of education have been put to the test of experience, and announced that a school on similar lines will be opened at Streatham Hill, London, next January. A principle which he holds to be of fundamental importance is the adjustment of educational methods and curricula to the biological changes occurring in the pupil, and, above all, the changes that take place at the age of puberty. This gives his doctrines a special interest at the present time, when the question of " secondary education for all " is being widely canvassed. It is perhaps a misfortune that he has labelled them with the portentous name " Anthroposophy."

PROSPECTUSES for the year 1924–25 have been received from a number of technical colleges in London and the provinces. The Northampton Polytechnic Institute offers a great variety of courses in mechanical and electrical engineering, optical engineering and applied optics, technical chemistry, horology, and women's trades and domestic economy. The part-time day classes for young persons employed in electrical and optical trades which have, owing to the propaganda work of a well-known electrical firm, been successfully maintained since 1918 despite the discouragement to which continuation classes have been subjected throughout Great Britain, will be continued. The Sir John Cass Technical Institute provides evening classes for persons engaged in chemical, metallurgical, electrical, petroleum, and the fermentation industries, and in artistic crafts and the tailoring trade. Full facilities are offered in the Institute's laboratories for special investigations and research. The Cordwainers Technical College offers both day and evening classes in the technology of the leather-working industries The former include two-year courses in which the scientific and managerial as well as the more practical aspects of the industry are dealt with. A certain number of free places at the Imperial College of Science and Technology, South Kensington, are available for students who desire to undertake post-graduation study. The Technical College, Bradford, gives particulars of three-year Diploma (Associateship) courses in textile industries, chemistry, dyeing, engineering, physics and, exceptionally, biology. Entrants for these courses are required to pass a College entrance examination of matriculation standard if they have not already passed an examination of equivalent standard. The College offers also shorter courses, both full-time and part-time, and training in methods of research.

IN view of the efforts being made in Great Britain to foster interest in aviation, and of the announcement of Government support for light aeroplane clubs, special interest attaches to the facilities available for the study

of the science of aviation and of the art of flight. In accordance with the opinion expressed by the Committee on Education and Research in Aeronautics that "The Imperial College should become the Central School for advanced study in Aeronautical Science," a Department of Aeronautics was established in 1920–1921 at the Imperial College of Science and Technology, London, with the approval and financial support of the Government and under the direction of Sir Richard Glazebrook. We have received a prospectus of the reorganised department. It is now under the direction of Prof. L. Bairstow, who is Zaharoff professor of aviation, and is assisted by two assistant professors on design and on meteorology, and by five lecturers on airships, on air navigation, on strength of structures, and on engine design. The assistant professorship in meteorology is at present vacant: all the other posts are filled by distinguished exponents of their subjects. As is to be expected, the department is in the main a school for post-graduate work, and its aim is in the direction of the encouragement of research, as well as in the co-ordinating of experimental work carried out by individual workers at experimental stations in different parts of Great Britain. A complete course takes two years, the first being spent in study at the College and the second in research or in experimental work. A special one-year course is also offered for advanced students, two terms at the College and the third term in experimental work at a research station or at the National Physical Laboratory, Teddington. The Department of Aeronautics at the Imperial College has already achieved considerable success: it will no doubt become one of the foremost centres of aeronautical study in the world.

TECHNICAL and evening classes provided by the London County Council opened this week. Last session about 120,000 students attended the evening institutes in London and 51,000 the polytechnic and technical institutes, making all told about 170,000. This was an increase of nearly 7000 over the figures for the previous year. Increases in attendance occurred mainly in the classes for women's subjects and for cultural and commercial education; there was a slight decrease in the numbers attending technical classes. Forty years ago the number attending the "night" schools of the period was 10,000. Despite the increase in numbers since then, the fact remains that, even to-day, only about one Londoner in three continues his or her education beyond the elementary school stage. Among recent developments may be mentioned the teaching of petroleum technology, oxy-acetylene welding, classes for the scale and weighing industry, and for textile distributors, musical instrument making, and an advanced school of rubber technology, science teaching in connexion with commodities and the marketing of commodities, technical optics, and aeronautics. A panel of about 10,000 instructors has been appointed to give the instruction; it is computed that about 80 per cent. of these are actually employed in the trades and professions they teach. The amount spent on vocational and cultural classes of this description in London is about 1¼ million pounds a year. The bulk of this expenditure is met in equal proportions by the Board of Education and the London County Council, the balance being derived from the fees of students and endowments. For the information of parents and older students, an illustrated "Guide to Continued Education in London" has just been published for the London County Council by the University of London Press. This may be obtained from any bookseller at 6*d*. a copy.

Early Science at the Royal Society.

September 21, 1664. Dr. Wren being desired to defer no longer the making of a larger telescopical moon for the Society, promised to do it against his next coming to London; upon which it was ordered that the treasurer should pay for a globe of that size, which Dr. Wren should choose at Mr. Moxon's. Several experiments were made. [Oldenburg, in a letter to Boyle, dated at London, September 22, 1664, gives some account of what passed at this meeting, where, he observes, they had the company of a Parisian academist, recommended to Sir Robert Moray and himself. I dare say (he says) he will extol our institution and proceedings to the sky, whensoever he comes; though I must say we grow more remiss and careless than I am willing to expatiate upon Yet this I must say to a person, that I am sure hath a concern for our prosperity, that nothing is done with the king for us]

September 22, 1679. Ordered—that Mr. Hunt take care to have all the instruments of the Society now in the custody of Mr. Flamstead at Greenwich immediately removed to Gresham College; and that Sir Christopher Wren and Mr Hooke be desired to go thither, and take what care they can in it; and that in the meantime Mr. Hooke write to Mr. Moore about the same, and desire to have them carefully sent home.

September 23, 1663. The president gave an account of the experiment committed to his charge, about the descending of water purged from air, proposed formerly by Mons. Huygens, and several times tried before the Society;. which the president affirmed to hold good upon every accurate trial He was desired to prosecute the experiment with quicksilver, and to bring in the particulars of the whole success in writing, together with the solution of this phenomenon.—There was read a petition of the fishmongers, presented to the Parliament, concerning the annoyances, whereby the fry and brood of fish is destroyed, and the several ways whereby the same may be preserved. This was communicated by Mr. Graunt.—The operator was ordered to have ready against the next meeting the iron balls for the trying of gun-powder and gold-powder; as likewise the compressing engine; and the dog, for the cutting off a piece of his skin.

September 24, 1662. Mr Winthrop read his paper concerning the conveniency of building of ships in some of the northern parts of America, there being several reasons, that may be propounded, as motives encouraging thereto. Among these, that it is not a new project the building of ships in those parts, for there hath been sufficient experience already made, there having been every year some built (great or small) for above these twenty years. There were this summer divers here at London, that were built over there, whereof two of about two hundred tuns: there is one now of an hundred tuns in this river, that was built there: there have been formerly some of three hundred and four hundred tuns built there. There hath been also, and is daily tar and pitch made; and much experience hath been made of the masts of those parts; many having been brought over hither.

1677. It was ordered that the officiating secretary taking short notes of all that passes at the Society or Council before the rising thereof, read the said notes in order to see that they be rightly taken.

September 25, 1661. Mr. Croune was desired to try some experiments of the weights of liquors: the lord viscount Brouncker to make the experiments of two pendulums: Dr. Goddard to prosecute his trials of sinking bodies under the surface of the water: Dr. Charlton to try the experiment of the freezing of salt water: Sir William Petty, a discourse on clothing.

Societies and Academies.

LONDON.

The Institute of Metals (Autumn Meeting), September 8.—W. M. **Corse** (autumn lecture): Recent developments in non-ferrous metallurgy in the United States, with special reference to nickel and aluminium-bronze. Some account is given of nickel, its occurrence, and smelting, and of the Orford, Mond, and Hybinette processes of refining. The copper aluminium alloy known as aluminium bronze is next described. This series of alloys has found many important uses, such as for worm gear wheels for motor trucks, automobile parts and other structural pieces requiring resistance to vibratory stresses or fatigues. The addition of lead to the standard aluminium bronze has given a new alloy of good wear-resisting properties. The dream of many a foundryman to avoid the use of sand for moulding purposes may come true, if the new Holley "long life mould" process using these moulds made of cast iron proves to be the success that is at present indicated. This applies to mass production work. There are also references to Ambrac metal, Frary metal, and the nickel chromium iron alloys.

PARIS.

Academy of Sciences, August 25.—M. Guillaume Bigourdan in the chair.—MM. **Bigourdan** and **Giacobini**: Observation of the total eclipse of the moon of August 14, 1924, made at the Observatory of Paris.—F. E. **Fournier**: Safety manœuvres, guarding against risks of collisions of two squadrons, in line of file, having to cross routes during fog.—Guiseppe **Belardinelli**: The resolution of algebraic equations.—Michel **Akimoff**: The approximate expression of Fourier-Bessel transcendentals of several variables, which occur in Kepler's problem.—P. **Appell**: Remarks on the preceding communication.—G. **Sagnac**: Classification of double stars.—T. **Batuecas**: Revision of the weight of the normal litre of methyl oxide. The value found, 2·1097, is in close agreement with that obtained by G. Baume in 1908 (2·1096). The atomic weight of carbon deduced from this is too high (12·033) and hence either the data for the compressibility of the gas require revision or the law of limiting densities of Daniel Berthelot is not rigorous for a gas so easily liquefied as methyl ether.—Léon **Moret** and Georges **Carrette**. Discovery of the marine Lutetian at the Roc de Chère (Lac d'Annecy).

SYDNEY.

Linnean Society of New South Wales, July 30.—Mr. R. H. Cambage, president, in the chair.—Marguerite **Henry**: (1) Notes on breeding Entomostraca from dried mud, and their habits in aquaria. The relative prevalence and persistency of the different species and their method of reproduction under artificial conditions are described. (2) Entomostraca collected in the vicinity of Auckland, N.Z. Of the ten species collected by Mr. T. Steel, one is new and is also the first of the genus Brunella to be recorded from New Zealand. Several of the species have hitherto only been recorded from the South Island.—J. R. **Malloch**: Notes on Australian Diptera. No. iii Notes on some Diptera—Acalyptratæ, in which two genera (one in Chloropidæ and one in Agromyzidæ) and eleven species (five in Chloropidæ, two in Ephydridæ, three in Agromyzidæ and one in Asteiidæ) are described as new.—G. H. **Hardy**: A revision of the Australian Chiromyzini (Diptera). In 1920 the author published a paper revising the tribe Chiromyzini. The Australian species are here considered The males of four species, hitherto only known from the female, are included, and another is described as a new species.

Official Publications Received.

Imperial Earthquake Investigation Committee Seismological Notes No. 6, July. Preliminary Note on the Great Earthquake of S.E. Japan on Sept. 1, 1923 By A. Imamura. (Tokyo: Department of Education.)

Illustrated Catalogue of Specimens from Prehistoric Interments found in the North-East of Scotland and preserved in the Anthropological Museum, Marischal College, University of Aberdeen. By Prof. R. W. Reid. Pp. 50+2 maps (Aberdeen: The University Press, 1924.)

Report on Tests of Miners' Flame Safety Lamps fitted with Open Mesh Gauzes, carried out at the Mines Department Lamp Testing Station, Eskmeals. (London: H M. Stationery Office, 1924.) 3*d*. net.

National Physical Laboratory. Report of the Advisory Committee for the William Froude National Tank for the Year ending December 31, 1923. (London: H.M. Stationery Office, 1924.) 6*d*. net

Report of the Aeronautical Research Committee for the Year 1923–24. Pp. 50. (London. H.M. Stationery Office, 1924.) 2*s*. 6*d*. net.

Ministry of Agriculture and Fisheries. Fishery Investigations. Series II. Vol. VI, No. 4. 1924. An Account of Investigations into the Cause or Causes of the unusual Mortality among Oysters in English Oyster Beds during 1920 and 1921. Part II. Chemical Reports (1) by George Stubbs, Andrew More and John Ralph Nicholls, and (2) by Dr. O. L Brady. Bacteriological Reports by Prof. J. Eyre. Report on Field Work by F. S. Wright. Biological Investigations by Dr. J. H. Orton. Recommendations as to Further Research by Dr. J. H. Orton. Pp. 69. (London: H M. Stationery Office, 1924.) 7*s*. 6*d*. net.

Apia Observatory, Samoa. Report for 1921. Pp. 62. Report for 1922. Pp. 63. (Wellington: W. A. G. Skinner, 1923)

A Summary of the Meteorological Observations of the Samoa Observatory (1890–1920). By G. Angenheister. Pp. 56. (Wellington: W. A G. Skinner, 1924)

Kungl. Svenska Vetenskapksakademiens Handlingar. Tredje Serien. Band 1, No 2: Researches on the Distribution of the Absolute Magnitudes of the Stars. By K. G Malmquist. Pp. 77. Band 18, No 23: A Study of the Properties of Globular Distribution. By S. D. Wicksell. Pp. 16. On the Dissection of Frequency Functions. By C. V. Charlier and S. D. Wicksell. Pp 64. (Stockholm: Almquist & Wiskells.)

L'Éclipse totale de soleil des 20–21 août 1914. By H. G. Block. Pp. 15. (Stockholm: Almquist & Wiskells.)

Ordnance Survey Map of Roman Britain. Scale 16 miles to 1". Pp. 8 +map. (Southampton: Ordnance Survey.) 4*s*.

Records of the Botanical Survey of India. Vol. 10, No. 1: The Botany of the Abor Expedition. By I. H. Burkill. Pp. 154 (Calcutta: Supt. Government Printing, India.) Rs. 4, As. 4.

Annals of the Transvaal Museum. Vol. 10. Part 4. Pp. 197–252. (Cambridge: At the University Press.)

Ministry of Agriculture and Fisheries. Fisheries Investigations. Series 2, Vol. 7, No. 2. 1924. Report on Exploratory Voyages to Lousy Bank and Adjacent Areas By Lt. E. L. Pawsey and F. M. Davis. Pp 22+2 charts. (London: H.M.S.O.) 3*s*. net.

Australasian Antarctic Expedition 1911–14. Scientific Reports. Series C. Zoology and Botany Vol. 6, Part 6 Polyzoa. By W. Thorneby. Pp. 22+five text figures. (Sydney: A. J Kent.) 2*s*.

Astronomical and Magnetical and Meteorological Observations made at the Royal Observatory, Greenwich, in the year 1921 under the direction of Sir Frank Dyson. (London: H.M.S.O.) 1*l*. 15*s*. net.

Cape Astrographic Zones. Vol. 10. Catalogue of Rectangular Coordinates and Diameters of Star Images. Derived from Photographs taken at the Royal Observatory, Cape of Good Hope. Commenced under the direction of Sir David Gill, and completed by S. S. Hough. Zone 50°. (London: H.M.S.O) 4*l*. 10*s*.

Report of the Aeronautical Research Committee for the year 1923–4. Pp. 50. (London: H.M.S.O.) 2*s*. 6*d*. net.

Department of Agricultural and Technical Instruction for Ireland. Memoirs of the Geological Survey of Ireland. The Geology of the Ballycastle Coalfield, Co. Antrim. By W. B. Wright, with chapters on the Palæontology of the field by E. A. Arber and L. B. Smyth. Pp. 187. (Dublin: The Stationery Office.) 7*s*. 6*d*.

Diary of Societies.

TUESDAY, SEPTEMBER 23.

INSTITUTE OF MARINE ENGINEERS, at 6.30.—E. B. Seymour Norton: An Engineer's Life in Eastern Oilfields.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—Capt. P. P Eckersley: The Development of Broadcasting in Great Britain.

WEDNESDAY, SEPTEMBER 24.

RADIO SOCIETY OF GREAT BRITAIN (at Institution of Electrical Engineers), at 6.—Prof. W. H. Eccles: The Latest Developments of the Position of the Scientific Amateur under the Wireless Telegraphy Regulations. (Autumn Presidential Address)

THURSDAY, SEPTEMBER 25.

INSTITUTION OF LOCOMOTIVE ENGINEERS (at Engineers' Club, Coventry Street), at 7.—Lt.-Col. E. O'Brien: The Future of Main Line Electrification of British Railways.

FRIDAY, SEPTEMBER 26.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—O. Brockbank: The Wilderness of the Wanderings.

SATURDAY, SEPTEMBER 27.

SCHOOL NATURE STUDY UNION (Anniversary Meeting) (at London Day Training College), at 3.—G. H. Gater. Address.

SATURDAY, SEPTEMBER 27, 1924.

CONTENTS.

Editorial and Publishing Offices:
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.

Editorial communications should be addressed to the Editor.
Advertisements and business letters to the Publishers.

Telephone Number: GERRARD 8830.
Telegraphic Address: PHUSIS, WESTRAND, LONDON

University Staffs and University Finance.

THE recent revision of the conditions of tenure and salary of the non-professorial staff at the University of Edinburgh, referred to in a letter published in NATURE of May 24, raises again the whole question of the position of these grades at universities generally, and the extent to which their position is satisfactory alike to themselves and to the institutions they serve. That such staffs believe themselves the victims of grievances is apparent to any one conversant with the present situation at most universities in Great Britain.

During the past quarter century, with the growth of specialisation and the increase in student numbers, a progressive change has occurred in the character of the work undertaken by a large proportion of these staffs. From the stage of being mere personal assistants to the professor, they are now very frequently directly responsible for honours courses and for the supervision of the work of research students. From the point of view both of disseminating existing knowledge and of opening up and exploring new fields of inquiry, they have become an indispensable section of every university.

Unless adequate facilities are provided, however, and the conditions such as to enable these individuals to devote their free time to original reading, thought, and inquiry, it is clear that this work cannot be conducted efficiently. It is notorious that demonstrators and lecturers of various grades, with increasing social responsibilities as they grow older, with no security of tenure, inadequate salaries for the positions they are expected to maintain or the interests they are required to develop, crowded in their grades with no prospect for the great mass of real advancement because of the paucity of higher posts, spend arduous nights away from home, teaching evening classes or undertaking other hack-work to supplement their meagre salaries. It is absurd to pretend that under such conditions their normal duties can be efficiently conducted, and an inquiry into the whole question of payment and the evils that are arising from continued under-payment is undoubtedly urgent before the rot has time to inflict permanent harm on university teaching.

The whole standard of staffing is affected by this question. The obvious lack of prospects of the junior staffs acts as a deterrent upon the better graduate from entry into the profession, and impels the ambitious demonstrator or lecturer, eminently suited as he may be to an academic career, to turn to secondary school teaching, where, with even inferior qualifications, he is certain to rise from 300*l.* or more per annum to 500*l.* or 600*l.* instead of remaining at a fixed salary

of 300*l.* or 400*l.* While it is true that certain individuals will always be attracted to university work, irrespective of the conditions, it is quite clear that the factor of low salaries is operating to drive the better type of graduate into school teaching and government service and to force the universities to retain on their staffs inferior men. The effect of this on our educational system will presently be apparent. While it is essential that the best personnel should be attracted to the academic teaching profession, they will only be induced to enter and remain by offering a career comparable to that obtainable in other fields. This can scarcely be said to be the case at present at Edinburgh, as we are informed in a memorandum issued by a committee of the staff that during the past year the average salary of the members of the non-professorial staff (248) was about 260*l.* and that for the professorial staff (52) about 1100*l.* It may be noted that where the work and responsibility of the one grade shade continuously into those of the other, this disparity in reward is too acute to be regarded as wholesome.

It is, however, not merely with the question of salary that these grades are apparently dissatisfied. While it is a fact that in a few universities, within the past few years, some members of the lectureship and readership grades have been admitted to membership of senates, no adequate scheme of direct representation of non-professorial grades on the senates and governing bodies of universities has been put universally into operation. There is in general no constituted machinery whereby members of these grades may make known their views on matters affecting the general policy of the university and their own interest. Such a state of affairs cannot, of course, endure. The devolution in administrative and educational responsibility and initiative, essential in the modern university, implies on the part of the staff a progressive experience and familiarity with problems affected by university policy which ought, in the interests of efficiency, to be fully utilised. No greater mistake could be made by any governing body than to regard the staff as mere employees or "hands."

Associated with these two aspects of the question, that of finance and that of policy, must be mentioned the tendency which has manifested itself of earmarking increases of capital, whether by gift or otherwise, for the foundation of new chairs or the creation of new buildings. If gifts of this nature are never to be expended on the salaries of the staff, not even towards the salaries of the additional staff required to carry on the work of the new extensions, the position of the non-professoriat must become more acute, especially since it has become customary to discuss the salaries of the latter always in relation to current income.

From the point of view of the institutions themselves the problem is not easy. Faced with a decrease in student membership and revenue from fees, increases in expenditure and decreases in grants, heavy rates and requests for the extension of their functions, their lot indeed is not a happy one. The standard of teaching must be maintained, the research spirit must be fostered, and the educational needs of a rising democracy catered for.

The problem is twofold—administrative and financial. A little, perhaps very little, might be effected by increased economies in administration, but in the shaping of a progressive and enlightened policy everything is to be gained and nothing lost by the fullest representation of the staffs on the governing bodies. On the financial side, however, the position is much more critical. The saturation point has probably already been reached as regards income from fees; further increase is, moreover, undesirable in the light of present-day demands for the removal of financial barriers to a university education. Meanwhile, as an immediate proposal, if the Government is in earnest in its professions on education and on the injustices of Local Rating, we see no reason why clauses exempting educational institutions from local taxation should not be introduced into the Bill on Local Rating which we understand it has in contemplation. This would in effect secure to universities a contribution from local authorities equal to the present taxation paid by these institutions without the unpleasant necessity of begging for such a grant. The suggestion seems at any rate worthy of consideration.

In any event, the financial situation of the universities in Great Britain is really too critical for any mere tinkering to ease it permanently. All such institutions have more than a merely local interest, and as such their finances require to be considered on a broader basis. Their functions and responsibilities interweave and overlap, and to require each body to produce a budget which balances in itself is foolish finance. At what point the universities will be ready for drastic changes it is impossible to say, but some such change is inevitable and probably imminent. A broadening of the budgeting basis, a closer and more deliberate interlocking of the functions of separate institutions, would probably result not merely in a more effective economy in administration, but would unify the standard of grading in the staffs from one university to another. The time is, indeed, ripe for a Royal Commission on the financial position of the Universities of Great Britain, excluding Oxford and Cambridge.

Rice.

Rice. By Prof. E. B. Copeland. Pp. xiv + 352 + 18 plates. (London: Macmillan and Co., Ltd., 1924.) 20*s.* net.

IF all the rice grown in India were planted in the British Isles, there would not be standing room for it. Yet the area under rice in India, with the exception of Bengal, is practically confined to a coastal fringe and is far from supplying the requirements of the people. The *per capita* ration for a rice-eating population would probably fall something short of three pounds a day, and the consumption in India is more like one pound. The staple food in a great tract in the north is wheat (there are 50,000 square miles of wheat in India), while the main cereal food of the population in the remainder consists of various millets. In other words, the ninety million acres under rice in India fall far short of the requirements of the country, and to a large proportion of the population rice is an almost unobtainable luxury. At the conclusion of the Armistice, festive gatherings were held in all parts of India, and at one in which the writer took part, representatives of all the neighbouring tribes were given a substantial meal. It transpired that some of these had never tasted rice, and, the quantity not being stinted, the unique spectacle was witnessed of the emaciated human frame swelling visibly during one short afternoon into comfortable rotundity.

China and Japan are two other great rice countries, and although statistics are not available, it is probable that somewhat similar conditions prevail there also, in spite of a distinctly higher scale of living, for we know that vast quantities of millets are grown in both of them. In northern China wheat is the main cereal. On comparing the maps of world distribution of rice and wheat, these crops are seen to be wonderfully complementary, the former spreading over the warmer portions and the latter over the colder; but the true rice zone has a much more restricted range, being concentrated in the monsoon tract in south-east Asia —Japan, China, India, Indo-China, and the Malay Archipelago.

Outside the region of the monsoons, rice appears sporadically all over the tropics, often being introduced to feed Asiatic labour, and even extends beyond the limits of the tropics into southern Europe, north and south Africa, and the New World (maize, of course, being the staple cereal there); but the area devoted to its cultivation in these parts is practically negligible when compared with that in the monsoon countries named above. The statement that one often meets with, that more than half the human race eat rice, is presumably based upon the large populations crowded into south-eastern Asia, but it should be accepted with some reservation. This appears to be recognised by Prof. Copeland, for he merely remarks that "it is probably the staple food of the greatest number of people."

The book is frankly one-sided, but this may, perhaps, be regarded as one of its greatest merits. Any attempt to cover the whole rice world, with its multitudinous varieties and agricultural practices, would require such a volume or series of volumes as would be a weariness to the general reader, if not out of his reach on account of costliness. We have nothing but praise for the author on the result of his effort, coupled with a sense of gratitude for his summarising, in small compass, the more important literature which has sprung up in various centres as the result of their invasion by western science. Most of this literature is altogether inaccessible, even to students in Great Britain. Prof. Copeland deliberately chooses the United States and the Philippines for his main descriptions of agricultural practice, on the sound plea of his thorough familiarity with the cultivation of rice in these countries. Of the countries dealt with, the United States claim fifty pages and the Philippines forty, while sixty pages are divided into short sections on India, Siam, China, Indo-China, Ceylon, Malaya, Java, Japan, Africa, Latin America, Spain, and Italy; more than half of these pages go to India (13), Java (8), Japan (7), and Italy (8). The rest of the book contains general chapters on botany, climate, soil and water, diseases and pests, seed and varieties, and the uses of rice; and in these chapters there are frequent references to such literature as has been published in all of these countries.

The choice of the United States and the Philippines for main treatment is abundantly justified by the fact that they represent the extremes in climate and agricultural practices. It has been stated that although labour is twenty times cheaper in China than in the United States, rice can be grown at less cost in the latter country. One man can only work one or two acres of rice in China, whereas, with the up-to-date agricultural machinery developed in cereal culture in temperate countries, a man can manage 80 acres in the United States. Yet the average yield of rice per acre appears to be only moderate. Analysing the crops in various countries given in the latest Statistical Year-book of the International Institute at Rome, we find that the greatest yields are obtained in Spain and Hawaii. High yields are also obtained in Italy, Egypt, and Japan; moderate in the United States, Java, India and Indo-China; while very low ones characterise Ceylon, the Philippines and Borneo. Judging from this point of view, the choice of the Philippines would not appear to be so satisfactory, especially as the total

output is very small in comparison with that of the great continental monsoon areas. But no country can be compared with these islands in the variety and picturesqueness of its paddy fields, as is at once evidenced by the two striking photographs of the Igorot cultivation in N. Luzon, fitly illustrating the labour involved through countless generations in terracing the almost impossible slopes among the mountains which are characteristic of the group. We must, however, guard against the idea that these terraces are in any way typical, and refer the reader to the pictures opposite to p. 234 for the more usual appearance of the paddy fields in the tropics. For the rest, the Philippines present sufficiently clear cases of the practices of indigenous tropical rice-growing; and there is always the author's plea as to his own intimate personal knowledge, which outweighs other considerations. His account of rice cultivation in the Philippines is indeed clear and interesting.

Prof. Copeland's agricultural classification of rices could, however, with advantage be somewhat widened, if for no other reason than to emphasise the extreme adaptability of this remarkable plant, on which the author insists. The classes given for the Philippines are four in number: clearing or *caingin*, upland or *secano*, *sabog* or broadcasting, and typical lowland (presumably transplanting). These are all present in India, although, as in the Philippines, the first named is extremely rare and fast disappearing; but at least two if not three classes should be added to make the classification more complete. The most interesting case is that of "dry paddy," which is grown just like many other crops in parts of India, on dry land with small rainfall under intensive dry farming methods. This paddy is drill-sown and best grown on black cotton soil; indeed, we believe that it is one of the curious *payira* crops, which will grow to maturity, once a sufficient fall of rain ensures satisfactory germination, without any further moisture than that of the air. This is obtained by the soil from certain moisture-laden winds ("crop winds," or *payira*), which blow during two or three months of the dry season. Then Indian "wet paddy" should be divided into two classes, which may be called swamp and irrigated respectively; the first, where the seed is sown on the margins of temporary lakes filled by the surplus of the monsoon rains and slowly drying up as the paddy ripens; and the second or ordinary lowland paddy, where it is absolutely necessary that a constant slow current of water four to six inches deep should pass over the ground, thus continuously changing the water. Then there is the "deep water paddy" mentioned by the author in another place: as to this, briefly, the writer has seen the oxen ploughing the land with the water almost hiding them completely, and the crop is said to be frequently harvested in boats. It is, of course, obvious that each of these methods will only be applicable to distinct varieties of the plant, and the agricultural practices are entirely different. Some interesting photographs of field work illustrate the chapter on the Philippines, and these fairly represent those in the monsoon tract.

In the United States section, Prof. Copeland concentrates his attention on the irrigated, Californian zone which is practically rainless during the growth of the crop. The areas in thousands of acres in the four principal rice States were in 1920 (the maximum), in Louisiana 700, Texas 281, Arkansas 175, and California 162, but were considerably less in 1923. The brief account given of the first three, the Gulf States, is useful, but, as good accounts in bulletin form are available of the Californian area and much less so regarding the other, we should naturally have preferred a straightforward account of this larger and older rice tract. This is especially so because of what we may call the fascinating account given by the author of the section chosen, a term which can scarcely be applied to such information as we have been able to gather on the Gulf States cultivation.

Turning to the general chapters, the first is appropriately devoted to the botany of the rice plant, and, as we gather, this chapter is written at any rate largely by another author. The morphological details of the rice plant are not very easy to describe without a series of adequate drawings, and this chapter is not illustrated. There is no picture of the rice plant, or of any of its parts, and some of the peculiarities, such as the leaf parts, are somewhat difficult to envisage; while a clearly drawn longitudinal section of the grain would make much of this and later chapters more easy to read and understand. It is scarcely usual to describe a graminaceous flower as "perfect," because the rice plant has six stamens in place of the usual three: the seed is described as "consisting of two thin coats, the endosperm and the embryo," and this scarcely conveys the fact that it is built on identical lines with the wheat seed.

In the part dealing with the physiology of wet paddy, a review of the literature regarding nitrogen assimilation is quoted as showing that the rice plant differs from most others in depending on ammonium salts rather than nitrates. These conclusions may be correct for the free draining soils of Hawaii, but we doubt whether they will be so for wet paddy in the east. As bearing upon this subject, we may refer to work done by Harrison and others on the soil gases given off during the growth of wet paddy in Madras, in a series of six memoirs during the period

1913–1920, which have apparently escaped the authors. Green manuring forms an important part in the local agriculture of the paddy fields, this substance being provided by the weed flora growing during the dry period, any vegetable residues in the soil, and often very large quantities of added matter in the form of special classes of leaves. Harrison, on investigating the result of puddling this vegetable matter, which is the orthodox method of preparing the land for paddy in the east, came across an extremely interesting case of symbiosis, between the rice plant and the surface scum. This scum consists of algæ and bacteria which form an impenetrable gelatinous film on the surface of the water as growth proceeds. The gases escaping from the decomposing green manure get entangled in the scum, and play a considerable part in the nutrition of the crop. On analysis, the bubbles are found to contain methane, carbonic dioxide, pure nitrogen, and free hydrogen, in quantities roughly indicated by the figures 70, 30, 5, and 3 respectively. But as the plants grow the bubbles change in constitution; the hydrogen and carbonic acid disappear and the nitrogen steadily increases in proportion to the methane, until at heading time and onwards it becomes the predominant constituent. The details of this change are too intricate to be dealt with here, but the net result is that the carbonic acid gas is utilised by the algæ for their growth with the usual evolution of oxygen which, unable to escape, highly oxygenates the water and thus enables the roots to live in apparently impossible anaerobic conditions. All of the nitrogen from the decaying vegetable matter is lost in the free state, and Harrison surmises that the nitrogen required by the plant is obtained entirely from the mineral salts stored as nitrate in the soil during the alternating dry period when the ground is covered by the weed flora.

Another much longer chapter, on "seeds and varieties," and mainly botanical, occurs later in the book, and as it covers numerous points dealt with in the first chapter it is a little difficult to understand its complete separation. This is one of the most interesting chapters in the book, and discusses in detail the many difficulties in the way of those who have made tentative attempts at classifying the rices of their locality. Varieties of rice differ morphologically and physiologically, and those which are difficult to distinguish in the first sense are not infrequently totally unable to live under the same conditions. One of the most marked distinguishing characters, perhaps, is the period required by the different rices to mature, a factor which fits so remarkably with the varying length of time during which, in a dry country like India, there is sufficient water available for the growth of the crop. The author dallies with the idea that this varying maturation of the crop may have something to do with the length of day or some similar factor of climate, but this is difficult to apply to India where, in the peninsula at any rate, there is little difference in this respect throughout the year, and there are probably more varieties of rice in India than in all the rest of the world together. A case quoted from memory will sufficiently explain the difficulty in accepting this explanation. In parts of the Tanjore delta, it is the custom to plant two kinds of rice together, a short and a long type (say, 4 months and 9 months). When the short crop is ready, the whole field is cut and the matured rice reaped; this drastic action is said not to injure the long paddy, still in the tillering stage, but even to improve its crop by causing additional branching of the hitherto shaded young plants.

After discussing the attempts of various authors at classifying the rices of their localities, the author presents, in the form of a carefully compiled *questionnaire*, a list of the information required in all future descriptions, covering two and a half pages of small print. Among other interesting details he refers to the uncanny faculty of rice-eating peoples of distinguishing the varieties in the form of rice bought in the market by their flavour and cooking qualities. This experience, gained in the Philippines, also astonished the writer in Madras, when an eminent Indian agriculturist informed him that he was able to distinguish 186 different local kinds by the same characters. Such statements have been received with suspicion in Great Britain and, naturally, would appear incredible to us, who are at best acquainted with only a few kinds, bereft by their preparation of their distinctive flavours and much of their nutritive qualities.

This, however, is not the only case met with of the extraordinary power of discrimination in food possessed by the great races of vegetarians in the tropics, and the writer has been accustomed to describe it as a separate sense which is unknown to the peoples of temperate regions and especially to meat eaters. To bring home the point in another way equally remarkable: in a recent severe drought, almost amounting to the official "famine," in South India, shiploads of Burma rice—practically the only kind which reaches Great Britain from the east—were brought over by the Government; and it is recorded that one of the greatest difficulties encountered by the officials in charge of the famine camps was to induce the starving people to eat this unaccustomed food. Some, possibly in a weak condition, were said to have died of starvation with an adequate quantity of this rice lying before them.

The most important part, however, of this long chapter of 64 pages is the summary prepared by Prof. Copeland of the scientific work, mostly done during the last decade, aiming at the improvement of the crop, both in the East and in Europe and the United States. The crops in the tropics are almost always grown as a mixture of varieties or even species, and it is obvious that the first step is always to separate these, whether by mass selection, which usually comes first, or by the separation of pure lines; and it is in the latter direction that practically all the economic successes have hitherto been obtained. This is the case with wheat, cotton, jute, and other crops, and more so still with rice: almost the only crop in which crossing has been the main line of work is the sugar-cane, which is always reproduced in cultivation by the vegetative method. But the analysis of the separate characters of these crops has also commenced in most cases, bringing with it a world of difficulties, which show that progress along this line in the improvement of crops will be a long and intricate matter.

In the case of rice, the author asserts that the raising of improved varieties by cross fertilisation is additionally handicapped by the form of the flowers. The glumes are so thick and tightly closed until just before or even after anthesis, that natural crossing is of the rarest; and he can only point to one case in which artificial pollination has been successfully accomplished. In this case, the severity of the method, cutting right across the glumes with a sharp pair of scissors and emasculating by fine forceps, seems sufficiently drastic to defeat the ends in view. We may only remark that various scientific workers in India do not appear to have met with this difficulty in crossing rice varieties.

Space limits prevent an adequate consideration of the remaining general chapters, namely, those on climate, etc., pests and diseases, and the uses of rice. The first of these is very short, but the questions that arise are referred to in all parts of the book. As regards the second, rice in the tropics has always been spoken of as a crop which, by its extensive method of cultivation, has escaped the devastation by pests and disease so largely met with in other crops, and this is largely true. Undoubtedly, for various reasons there has been less attention paid to the crop in the tropics than to other cultivated plants; but the formidable summary which is presented in the 50 pages devoted to the subject—largely of work in Europe and the United States—is sufficient to raise doubts as to the correctness of this comfortable preconceived idea. The absence of any picture, beyond a couple of plates by Dammerman of borers in Java, is a distinct loss in this chapter.

The uses of rice, dealt with in the short final chapter of 10 pages, are briefly summarised; but, of course, a great deal more could have been said about them. The statement that the straw is "useless for fodder" will scarcely be accepted in India (as an example of a country where pasture is either non-existent or inadequate), for paddy straw is the main and often the only fodder during the greater part of the year in rice-growing tracts. It is true that this is less marked in Burma, where Indian visitors are accustomed to deplore the wasteful treatment of the straw; but here, owing to the sparse population, other sources are available for fodder and there is a larger amount of waste land than in any part of India. This sparse population is, it may be remarked, the chief reason for the export of rice from the east, for paddy is scarcely ever grown as a "money crop," any more than millets are: it is only when there is a surplus owing to an unusually good monsoon that enough can be spared to send any to the countries of the west. One last point, the use of the word "paddy" is rather strictly confined in the East to the crop and the raw unhusked product, and the additional meaning, which we have not met with before, of the space between the bunds confining the water, is to be deprecated.

C. A. B.

Science and Folly.

Foibles and Fallacies of Science: an Account of Celebrated Scientific Vagaries. By Prof. Daniel W. Hering. Pp. xiii + 294. (New York: D. Van Nostrand Co., 1924.) 2.50 dollars.

"LORD, what fools these mortals be," quotes the reader as he lays down Prof. Hering's book "Foibles and Fallacies of Science." Astrology, the transmutation of metals, perpetual motion, divination, prophecies, charlatanism, are some of the titles of the chapters, and they give a good idea of the contents of a book which contains much curious and interesting information.

But is the title of the book correct? The foibles and fallacies about which Prof. Hering writes are certainly not those "of science"; they are really those "of human nature." In fact, the chief interest of the book is the light it throws upon the folly of mankind, not only of the so-called uneducated masses, but also frequently of the highest intellects of the age.

All branches of science—at least all the older branches—have suffered from the pseudo-scientific and the charlatan; in fact, one could judge of the extent to which a branch of science comes into contact with human life by the extent of the foibles and fallacies which have grown about it. It is an instructive study

to try to work out the psychology of the makers of one type of fallacy, and as the weather has always been a favourite subject for the pseudo-scientific, we may usefully give a little thought to considering the ways of the weather prophets who figure so largely in Prof. Hering's book.

We need not devote much attention to the astrologer, for weather was not a speciality of his; it was only an incidental. It is in the compilers of almanacs that we first meet with the professional weather forecaster. The first of these predicting almanacs appears to have been Old Moore's, which claims 1700 as the date of its birth and is, we believe, still going strong. Similar almanacs are published in most countries, from which it would appear that there are still people who find these weather forecasts interesting and probably useful. That it is not only unintelligent people who put their trust in such forecasts is clear from the remarks one has frequently heard about the weather columns and diagrams which have appeared since the War in one of our contemporaries devoted to country pursuits, travel and sport. How can we explain this except by that peculiar trait of the human mind which makes us remember those things which fit in with our preconceived ideas and ignore those which would prove us wrong? Every success of a forecaster in whom we believe is remembered, and as we take no particular notice of the failures, our impression—perfectly conscientious—is one of unbroken or nearly unbroken success. Unfortunately, the same process produces an impression of a series of failures on the part of the official forecaster, for no other reason than that, because we are British, we distrust everything official, note his failures, and take his successes as a matter of course.

What, however, are we to say about the makers of the forecasts? Surely they check their forecasts and must be painfully aware of many dismal failures? Any one who has had much to do with this class of weather prophet must have been struck by their great sincerity. There is no money to be made out of weather forecasting, so charlatanism is no solution of the problem. The explanation, and we speak from much experience, is that these men have as a rule evolved a most complicated system on which they base their forecasts, and these systems are never in their final form. Hence, after every failure they re-examine the grounds on which they made their forecast, and then find that if they had only taken so and so into account, or put less stress on something else, they would have got a perfect forecast. The examination, instead of making them mistrust their system, rather makes them realise how perfect it is if only it is accurately applied.

Prof. Hering also devotes several pages to rain-making and rain-makers, and describes the chief methods employed, but he does not mention the method, evolved as a result of the visit of the British Association to Australia, of electrifying the upper atmosphere by means of kites and balloons, which was offered to the Australian Government by a gentleman with a very appropriate name. Here again we meet with a remarkable amount of credulity; for in most cases the rain-maker thoroughly believes in his method and is sure it will work if only tried on a sufficiently large scale. There is, however, one clever man who makes a very good living out of rain-making. Mr. Hatfield is prepared to go anywhere and make rain on the principle of payment by results. If Mr. Hatfield makes no rain, he asks for no pay; while if he does make rain, he only asks for payment at the moderate rate of 3000 dollars an inch. His rain-making equipment consists of a huge tank 20 feet high, in which he brews a mystic chemical mixture which he says "opens up the clouds." Mr. Hatfield has been extensively employed on these terms in the United States, apparently to the mutual satisfaction of every one concerned. It is difficult to see anything wrong with this, viewed as a business transaction.

If we have estimated the character and motives of the pseudo-scientific weather prophet correctly, he is not such a bad fellow after all, and probably the same could be said of most of those responsible for the other foibles and fallacies described in the book, but we doubt whether Prof. Hering would agree with us, for he is somewhat hard on scientific folly. G. C. S.

Cambridge Biographies.

Alumni Cantabrigienses: a Biographical List of all known Students, Graduates, and Holders of Office at the University of Cambridge, from the Earliest Times to 1900. Compiled by Dr. John Venn and J. A. Venn. Part 1 (in 4 vols.). *From the Earliest Times to 1751.* Vol. 3: *Kaile—Ryves.* Pp. v+504. (Cambridge: At the University Press, 1924.) 150s. net.

THE death of Dr. John Venn since the preface to Volume II. of this monumental work was written allows the reviewer to pay tribute to his magnificent services to Cambridge history and at the same time to emphasise the value of his son's contribution, not merely to the present volume, but also to the whole work. On him alone will now fall the duty of completing the Appendix, including the corrections and additions to the first three volumes. Isaac Newton apart, the present volume (Kaile—Ryves) does not include the names of many well known to science.

Among those whose names stand out on a first selection we may mention John Ray, the well-known naturalist, Nevil Maskelyne, Astronomer Royal, Thomas Millington, the alleged discoverer of sexuality in plants, and Robert Record, who introduced algebra to Britain. On slightly lower scientific grounds we may refer to Sir Hugh Platt, who conducted horticultural and agricultural experiments at Bethnal Green and in St. Martin's Lane, to John Lumley, who founded a lecture at the Royal College of Physicians, to Thomas Plume, founder of the Plumian professorship, to George Parker, second Earl of Macclesfield, president of the Royal Society, and to Roger Palmer, mathematician and political pamphleteer, afterwards created Earl Castlemaine and more generally remembered through his wife.

If science, however, does not figure prominently in this volume, the active part that Cambridge men played in all the religious and political movements of their time emerges clearly. Thus we find Thomas Legh, much employed in the suppression of the monasteries, and Matthew Mackarel, executed for supporting an insurrection against their suppression. Thomas Percye was one of the most active organisers of the Gunpowder Plot, while Thomas Knyvet searched the cellars of the houses of Parliament and discovered the plot. Several of the regicides were Cambridge men, as was also George Monck, Duke of Albemarle, largely instrumental in the Restoration. The ill-fated James, Duke of Monmouth, was Chancellor of the University, while Titus Oates tried two colleges but failed to secure a degree. Migration from one college to another was much more common in earlier times than nowadays.

Cambridge was also the home of many heretics. Hugh Latimer and Nicholas Ridley were the best known of those who were burnt at the stake. Many others settled in America and the West Indies to escape persecution. The strong position held by Cambridge men among English poets is reflected in the present volume in the names of John Milton, Christopher Marlowe, and Richard Lovelace, while other literary names worthy of mention are Thomas Nash, Thomas Otway, Matthew Prior, Andrew Marvell, and Samuel Pepys. The latter supplies one of the many human touches in a volume of short biographies. Others are found in the accounts of Thomas King, scholar of Eton and King's, who afterwards "kept the coffee-house in Covent Garden, called by his name"; of John Ruddle, the priest who exorcised a Cornish ghost; of Dr. William Oliver of "Bath Oliver" biscuit fame; and of Thomas Reresby, who was fined 1000*l.* in the Star Chamber for boxing the ears of Sir William Wentworth on the County Bench at Rotherham.

Our Bookshelf.

Uses of Waste Materials: the Collection of Waste Materials and their Uses for Human and Animal Food, in Fertilisers, and in Certain Industries, 1914–1922. By Prof. Arturo Bruttini. (International Institute of Agriculture, Rome.) Pp. xx + 367. (London: P. S. King and Son, Ltd., 1923.) 12*s.* net.

ONE of the outstanding features of the War was the abnormal shortage of food for man and beast, fertilisers for agricultural use, and of many other substances regarded as essential for various economic purposes. The urgency of the need led to a diligent search for substitutes, many of which were found among unregarded bye-products and so-called waste materials and among wild and cultivated plants of every description. Many of these substitutes merely supplied the need of the moment, and fell into disuse as soon as the crisis was past. Others were of more permanent value and in certain cases have retained a definite economic position.

As time goes on it becomes increasingly difficult to realise the great amount of work and thought that was applied to the discovery and exploitation of these waste materials, and Prof. Bruttini has rendered good service to the community by placing on record not only details of the commodities themselves, but also a history of the legislative and administrative measures adopted by the various belligerent countries to deal with these matters. No other writer has covered the ground so completely, and the "Uses of Waste Materials" provides an excellent outline of the information available to date, with adequate references to more detailed papers where such exist.

In outline the book deals first with the legislative and administrative aspects, and secondly with the methods of handling waste materials and their various properties and uses. The subject is treated under the four main headings of human food, food for live stock, fertilisers, and alcohols, oils and other industrial products, though in some cases the same raw material can be utilised for several purposes. Wherever possible, analyses are given, and for feeding stuffs the appropriate rations for different animals are frequently indicated. As regards fertilisers, much experimental work has been carried out to test various residues, both as to their actual fertilising value and their relative value when the cost of production is taken into account. Many have proved to be uneconomic on the latter score, but the tests have indicated various sources of potential manures, some of which may profitably be exploited. A comprehensive table of contents and a number of illustrations add their quota to the general usefulness of the volume under review, which should prove a valuable work of reference to all agriculturists and to many of those associated with industry. W. E. B.

The Evolution of Mathematical Physics: Being the Rouse Ball Lecture for 1924. By Dr. Horace Lamb. Pp. 48. (Cambridge: At the University Press, 1924.) 2*s.* net.

"THE profound study of Nature is the most fruitful source of mathematical discoveries." In this quotation from Fourier, Prof. Lamb gives the keynote of his lecture on mathematical physics. He traces the history

of the subject during the nineteenth century, showing how work initiated on the Continent was brilliantly continued in Britain. The great time of Britain began with Green, who was followed by the Cambridge galaxy, in the enumeration of whom Lamb excludes men still alive and names only Stokes, Kelvin, Maxwell, Rayleigh. Then a time came when Britain went barren and it has remained barren ever since.

What is the cause of this barrenness? Is it that the well of genius has run dry, or is it that in some way Great Britain fails to provide the geniuses with appropriate opportunities? It is a century since Fourier stated the condition of mathematical progress, and in his lecture Prof. Lamb shows how the advances of the nineteenth century in Britain were due to the wide and deep knowledge of both mathematics and physics possessed by the workers. It is necessary to ask to what extent our universities are fulfilling the condition laid down by Fourier and now emphasised by Lamb? The answer is distressing. Not only are mathematics and physics divorced so that a man takes his degree in one or other and not in the two combined, but also the total range of mathematics is being found too great for a man to cover, and the tendency is to give a degree on an increasingly fractional knowledge of pure mathematics. If the present tendency persists, the time will come when each mathematician will have a minute knowledge of his own highly specialised branch and his angle of vision will be so limited as to make any advance impossible for him even in his own branch.

The total range of mathematics and physics as at present treated at Cambridge is too great for any man to cover in a degree course, as is also even the total range of pure mathematics as at present treated. So long as the present treatment of these subjects endures, we shall continue to sink in the slough of uselessness just described, and if the process of subdivision and specialisation is allowed to continue, our sinking will be the more rapid. The health of mathematics in Britain requires that Cambridge should discover a means to reverse this process and should in some way sufficiently condense the essentials of mathematics and physics to enable the individual to attain a real knowledge of both.

Gas Engineers' Compendium: a Collection of Statistics, Formulæ, Rules and Data for the Everyday Use of Gasworks' Officials and Students. Compiled by Experts. Pp. 292. (London: Ernest Benn, Ltd., 1924.) 32*s.* 6*d.* net.

A COMPENDIUM should at least be compendious, that is to say it should be comprehensive, complete, and compact; the information it contains should be accurate. This bulky volume fails to justify its title when tested by any of these criteria. General statistics and statutory requirements relating to the gas industry, gas-making coals, retort settings, purifiers, gas-holders, gas producers, by-products, flow of gases in pipes, and data relating to gas distribution generally, the mechanical characteristics of steel beams, etc. of various cross sections are amongst the subjects upon which information and useful particulars are given. We have failed to find tables referring to values of the elastic moduli of materials (and these are required in connexion with certain formulæ contained in the book), data referring to viscosities of gases, coefficients of expansion of substances, vapour pressures and numerous other physical data with which the gas engineer is intimately concerned. Room could be found for these if the thirteen blank pages, blank parts of pages, and wide marginal spaces characterising the volume were utilised; Kaye and Laby's Tables would serve as an example of the type and format of a volume much needed by the gas industry.

The incompleteness of information contained in the present volume is sufficiently illustrated by reference to the inadequacy of the statement on p. 272 relating to the melting point of firebricks—the value for "ordinary" firebricks alone is given. In like manner, one value only is given for the melting point of an electric lamp filament (unspecified). Inaccuracy of some of the information contained in the volume may be exemplified by reference to the tabulated melting points of magnesium, tantalum, and other substances given on the same page. Values of the specific heats of gases, etc. (p. 273), are given only at ordinary temperatures, and these in some cases are incorrect, and certainly in the cases of air and steam are not the generally accepted values. The mathematical section containing the elements of trigonometry, tables of squares, square roots, cubes, cube roots, logarithms, antilogarithms, and trigonometrical tables is possibly both the least and most useful part of the volume. The information contained in the useful part consisting of 16 pages of this section can be obtained elsewhere at a cost of one penny. This volume contains 292 pages (not all filled) and costs 32*s.* 6*d.* *Verb. sap.* J. S. G. T.

The Rock Tombs of Meir. By Dr. Aylward M. Blackman. Part 4: The Tomb-Chapel of Pepi'onkh the Middle Son of Sebkḥotpe and Pekhernefert (D, No. 2). (Archæological Survey of Egypt, Memoir 25.) Pp. viii + 61 + 27 plates. (London: Egypt Exploration Society, 1924.) 42*s.*

THIS is a welcome continuation of Dr. Blackman's work, interrupted for nine years. Another large tomb, full of inscriptions, is here recorded, which had been opened by authorised native diggers, and left to destruction without adequate publication. These tombs of local princes give a detailed view of society some four thousand years ago. The great period of the pyramid builders was ageing to its fall, and pluralities and sinecures were the perquisite of high office. Forty-four titles belonged to the prince Pepionkh; some were the equivalent of modern degrees and honours which we express by initials, but others imply too much work for one man, such as Vizier, Chief Justice, Treasurer, Royal Deputy, Head of the Record Office, Keeper of the Granaries, and so forth. No doubt most of these duties were done by deputy, as he had sixty-four officials under him, all named in his tomb, and duly listed here. Beside these there are fifty relatives, who all had offices, and a hundred and ten dependants who also were thought worth mention. Thus more than two hundred persons all swelled the bureaucracy of this noble and lived on the estates. The good old man lived to a hundred, having "grown old very happily" and "never gone to bed vexed." The king under whom he thus flourished also lived to a hundred, in the peaceful

and fat autumn of that civilisation, soon to be scourged by a Syrian occupation.

The facsimile copies of all the sculptures and paintings are carefully executed, and are fully described; the inscriptions and translations have been discussed before publication, with various authorities. This may therefore be accepted as a final record, a kind of work which no nationality has done but our own, though sometimes executed for foreign patrons.

W. M. F. P.

Excavations in Malta. By M. A. Murray. Part 1. With a Chapter by G. Caton Thompson. Pp. iii+49+21 plates. (London: Bernard Quaritch, 1923.) 7*s*. 6*d*.

THIS record of excavations in Malta covers the work done by Miss Murray and her party in the years 1921–22. The most important site attacked was the cave of Ghar Dalam, in which Mr. G. Despott in the course of his excavation in 1916–17 discovered two teeth, since identified as belonging to Neanderthal man. An area of 40 feet by 60 feet was excavated down to rock, but beyond bones of the hippopotamus, some from a stratum which had hitherto proved sterile, no result of particularly noteworthy importance was obtained. Of the three remaining sites excavated, the most considerable was that of Borg en Nadur—remains on the slope of a spur running up from the bay of San Giorgio, at the top of which is the tower from which the site takes its name. The remains, which are well known to archæologists, include a dolmen flanked by an upright stone. In the area west of this dolmen, to which excavations were confined, a small apsidal building was brought to light which exhibits several points of interest and part of the wall of a forecourt. Miss Murray also examined the chamber behind the dolmen. No satisfactory evidence of stratification was obtained. The objects found included pillars, and pillar blocks, Bethel stones, hammer and polishing stones, a number of small chert implements and three fragments of bronze. The pottery, mostly fragmentary, Miss Murray, following Dr. Zammit, classifies as neolithic and bronze age, assigning a polished gray or black ware to the former, and the red with black decoration to the latter. It has been pointed out, however, that the attribution of the second type to the bronze age rests upon no very certain basis. If Miss Murray's results do not lead to any very decisive conclusions, she has produced a very careful, and therefore valuable, record of a considerable amount of work done in a limited time and at a trying season of the year.

Handbook to the Exhibition of Pure Science. [*British Empire Exhibition.*] Arranged by the Royal Society. Pp. 228. (London: A. and F. Denny, Ltd., 163a Strand, W.C.2, 1924.) 1*s*. net.

UNLIKE most Exhibition literature, which usually has a mercenary motive, patent or concealed, this publication is educational in the best sense of the word. The contributors to it are all investigators in the front rank, and their contributions summarise clearly and concisely all the recent advances in physical and biological science. Part I. contains articles concerning the structure of matter by "J. J.," Bragg, Rutherford, and Aston; relativity and astronomy are dealt with by the Astronomer Royal and Eddington; "wireless" topics by Glazebrook and Fleming; spectra by Fowler; meteorology by Napier Shaw and others; origin of man by Smith Woodward; physiology by Starling, Harris, Hill, Cathcart; and this list is not exhaustive. Part II. comprises a descriptive catalogue of the exhibits in the Exhibition of Pure Science at Wembley, together with introductory remarks by eminent specialists. In every case it has been sought to trace the development of a discovery or invention from the beginning to the latest application, and to show how the applications originated in research undertaken without any utilitarian motive. The handbook will be greatly appreciated, not only by those who visit the Exhibition, but also by all who are interested in modern science; and those concerned would do well to see it placed in the hands of all senior science pupils in the schools of the Empire.

An Essay concerning Human Understanding. By John Locke. Abridged and edited by A. S. Pringle-Pattison. Pp. xlviii+380. (Oxford: At the Clarendon Press; London: Oxford University Press, 1924.) 8*s*. 6*d*. net.

IT is possible to appreciate the reason for this abridged edition of Locke's great Essay and at the same time to regret its appearance. If it had to be done, no living philosopher is so qualified to do it well as Prof. Pringle-Pattison. It is issued for academic reasons and appeals to academic purposes. Every teacher of philosophy knows that it is useless and undesirable to expect the student to read the whole work intensively as he must read, say, Spinoza's "Ethics" or Kant's "Critique of Pure Reason" if he would understand those philosophers. Locke is prolix and also a large part of the Essay has lost the interest and influence it had. On the other hand, nothing is easier than to direct the student as to what is important and what comparatively negligible. Abridgments are unwise. However well-informed, it is certain, for it is human nature, that the reader will suspect that something of importance has escaped or been suppressed.

The Electrolytic Rectifier: for Electrical Engineers, Physicists, and Wireless Amateurs. By N. A. de Bruyne. Pp. vii+75. (London: Sir Isaac Pitman and Sons, Ltd., 1924.) 3*s*. 6*d*. net.

THIS is a useful little book and will be helpful to electrical engineers, physicists, and radio amateurs. The electrical engineer will appreciate the theory and the method described of using a rectifier to charge accumulators directly from alternating current supply mains. The book will also enable him to understand better the action of electrolytic lightning arresters. The physicist will find the author's experiments on the use of neon lamps with rectifiers suggestive. His experiments seem worth following up. The thousands of radio amateurs who have learnt by experience that hot cathode and mechanical rectifiers are fragile and costly to use for charging accumulators from the mains will learn that there are cheaper and no less efficient methods of charging them. The references given will be helpful to the serious student, and the description of the gas layer theory shows that it is in fair accord with experiment.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Five- (and Six)-Point Support: "Right as a Trivet."

THE earliest mention of the mathematical principle of Geometrical Fit, in five- and six-point contact, is found in the first edition, 1867, of Thomson and Tait's "Natural Philosophy," p. 131, § 198: "As an additional degree of freedom is lost by each successive limitation of a point in the body to a smooth surface, *six* such conditions determine completely the position of the body.

"Thus if six points properly chosen on the barrel and stock of a rifle be made to rest on six convex portions of the surface of a fixed rigid body, the rifle may be replaced any number of times in precisely the same position, for the purpose of testing its accuracy."

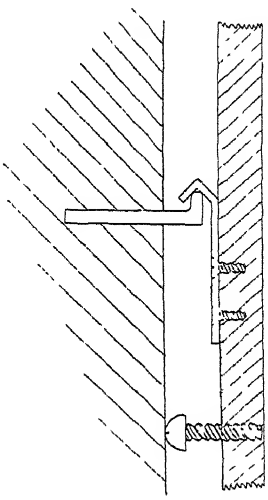


FIG. 1.—Five-point support for pictures on a wall

This message has not yet received the attention it deserves in the design of mechanical apparatus, for example, the Six-Point Rifle Rest. It is ideal in repetition work such as rifle small arm manufacture, where the parts require to be assembled at random. In Geometrical Fit there is no need for machining of the parts; the fitter's occupation is gone; and "Right as a Trivet" is an exact proverbial description of a perfect mechanical theorem embodying the Axioms of Geometrical Fit.

In the five-point support we proceed to describe, one contact is suppressed, allowing the body one degree of freedom, as we see in the trivet on the bars of a grate, free for a sidelong displacement, but always coming to a steady bearing. The sixth point is encountered by sliding the body up against a stop.

A length of electric conduit tube round a room will serve in the same way for the support of pictures, the tube resting in brackets fastened to the wall at dado height. Hooks on the back of the frame will hold the picture up at an appropriate height, leaving it free to be displaced sideways to any desired position; the cant from the vertical is settled by a round-headed screw in the back lower bar of the frame. The same method can be applied to bracketing out a piece of apparatus from the wall, leaving it free to be lifted off and replaced, and yet quite firm and steady in position.

The wall of a modern laboratory, for appearance and cleanliness, should be not the rough brick surface as at the Cavendish Laboratory, but of glazed brick with a dado some way up from the floor; a mop passed over it will wipe off the dust. A nail cannot be driven into this surface; and so the architect should give instructions for an iron plate to be built into a course of the bricks, at an appropriate level of dado, with a cornice lip projecting slightly; and no more is required for the support of apparatus or blackboard, wherever desired, or however heavy, as in Fig. 1.

If a nail must be driven, a board should be kept for the purpose, and then the board is hung up where required as a blank blackboard.

The method is ideal for a picture gallery, a Royal Academy exhibition. The Academician will stake out his claim and settle the height of his picture, and of the hooks in the back of the frame; and if dissatisfied there is no difficulty in his removal to another site on the wall.

In the oldest Academy of Art, the Pinacotheka on the Acropolis of Athens, the walls are still smooth marble, with no sign of a nail driven, and the professor, our guide, was puzzled how the pictures were hung, until I directed his attention to the groove in a horizontal course, giving the support described above.

Applied to the ballistic pendulum (Fig. 2) the five-point principle requires a suspension of five wires in appropriate spacing, to allow a block or sleeper to recoil parallel to itself; and no consideration is required of centre of percussion or oscillation; the point of impact is practically immaterial. The block moves all together, as in Euclid's definition of a solid body.

The suspension is made from a bracket held up

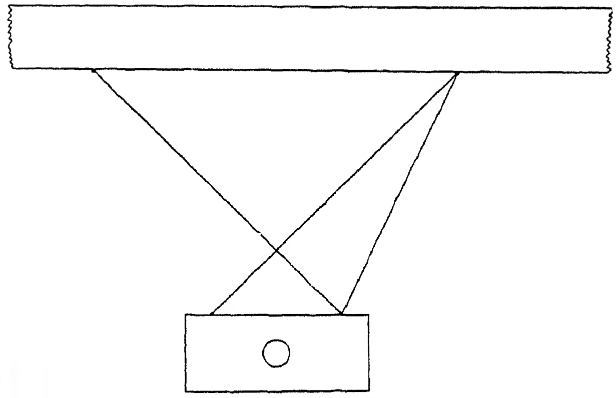


FIG. 2.—Ballistic pendulum.

against the wall in the manner described above; not from the roof, for which the architect never makes provision, and inaccessible at that, especially in a fire with the roof full of smoke. The electric chronograph has replaced the ballistic pendulum for careful velocity measurement, but there are still many applications where the pendulum can prove useful, economical, and accurate.

The psychology of the recruit must be considered at the first introduction to the use of his rifle, so as not to waste confidence in himself by throwing away his first shots. Ordered to lie down on the ground behind a rifle rest designed on this six-point principle, with the rifle in it trained on the target, say at 500 yards, he will be directed what to see on looking through the sights, and instructed in simple snapping practice under the careful eye of his instructor to see there is no flinch or wink on pulling the trigger, going through all the preliminary motions of opening the breech and inserting a cartridge, and ejecting the empty cartridge case by working the bolt. A live cartridge is then inserted without notice, and on pulling the trigger the unsuspecting recruit feels the kick, how it is not formidable with a proper hold. After this he can continue with his allowance of drill rounds, and find all shots in the bull's-eye. He will have acquired confidence in his weapon and himself, and realise that he can continue this standard of marksmanship; if only he holds the rifle straight and himself steady, the weapon and ammunition will do the rest. He is not discouraged at the outset by the

depressing experience of finding all his first series of shots going he knows not where.

In Geometrical Fit there is no need for machining the parts. The parts of a rifle can be stamped out in drop forging, and assembled at random, the natural skin left untouched to avoid rust. The only surface to require machining is a sliding contact, as of the bore of the rifle for the passage of the bullet, and the bolt action of the breech mechanism. When a rifle is assembled and tested by the proof rounds, the opportunity can be utilised of adjusting the sighting at the same time. The rifle is placed in the six-point rest, and the proof rounds fired, without aiming, at a card in the line of fire. The centre of mean impact is then marked on the card, and another workman follows to place the foresight in line on the muzzle, to be brazed on there afterwards. The operation of proving and sighting is thus carried on simultaneously from the same six-point rest.

These principles were too simple to appeal to the Enfield tradition; the complication of the bolt action was adduced as a triumphant refutation when I attempted to explain the theory.

Lord Kelvin had occasion to complain of the dogged opposition of his workmen, and was compelled to put it to them as a personal favour to carry out the six-point idea in his apparatus, allowing them the liberty of classing him as a fool, and paying their wages all the same. At Woolwich I was once just in time to recommend the principle for the suspension of a series of coat and hat racks, requiring to be removable and replaced on occasion. But we did not reckon with the smartness of the sapper artificer, careful to make a mechanical fit sideways, obliterating that degree of freedom.

The use of these brackets was made conditional on the possibility of their removal at a moment's notice. But, as a consequence of the R.E. science, the brackets could not be replaced without an intolerable amount of trial and error, calculable on the algebraical principle of Permutations.

At Finsbury Technical College the advice of Prof. James Thomson was enlisted by Perry for the design of a blackboard, in accordance with his idea of the requirements, and the following description is quoted from "Technical School and College Building," p. 152, by E. C. Robins, 1887.

Prof. James Thomson's blackboard, shown in plate 5 there, is so sensitive to movement, it may be moved up and down with the little finger, although the blackboard itself measures 14 feet wide by 6 feet 6 inches high.

According to Prof. Perry, "It is absolutely necessary the lecturer should not rub out a mathematical formula until the end of the lesson, and this requires a very long blackboard, the longer the better. As one who has to teach mathematics I say a blackboard should not be less than 30 feet long. A long blackboard is usually fixed to the wall. You can write perhaps at 6 feet from the ground to 3 feet, but it saves much needless moving to be able to write all formulas at about 5 feet from the ground

"It is of importance then to move the whole of the blackboard up and down with a touch of the finger, as Prof. James Thomson's arrangement enables you to do.

"Instead of hanging the blackboard by two chains over four pulleys, and having a very heavy balanced weight for the whole board, involving a tremendous amount of friction, we hang the ends of a well-framed board by two chains from the long arms of two levers; the shorter arms carry a heavy balance weight, and the only place where friction can occur is at the fulcrum of the levers.

"This allows a very large motion of the board for a small motion of the balance weight, a great convenience. When these fulcrums are well oiled, a touch of the chalk at any point of the board is sufficient to lift the blackboard."

Vertical grooves give sliding contact, arranged on scientific principles, to render jamming impossible, by the use of only three contacts. But Perry here had the same experience and difficulty as Thomson with the workmen. He complained how after he had been transferred to Kensington, he returned to find the blackboard had been put right by a skilled workman, quite sure the number of supports was insufficient, adding a fourth sliding contact. The result of making what he called a workman-like job was for the blackboard to jam.

However, in a recent visit to Finsbury Technical College, I found the blackboard had been restored again to its original Thomson design, and was in proper working order, easy up and down.

G. GREENHILL.

Mendelism and Evolution.

MEMBERS of the British Association during the recent Toronto meeting have had put before them the available evidence concerning the so-called "White Indians" of Panama. The purely biological interest of the discovery turns out to be as great as the anthropological; and, since it bears on correspondence which has recently appeared in the columns of NATURE, I should like to comment briefly upon it.

In the first place, then, it appears clearly established that the "white" condition behaves as a simple Mendelian recessive. The normal dark colour is completely dominant; there are no intermediates; all the "whites" show essentially the same deviation from normal; white × white gives only whites, but whites may be produced (together with normals) from the mating of two persons phenotypically normal.

The condition has been described as "partial albinism." If by this is meant simply any condition in which normal pigmentation is reduced, the term is applicable; but it should be noted that these people possess yellow hair and hazel eyes.

All the authorities who have examined them are agreed that the condition has no racial significance: the racial type has not been altered save in the one respect of pigmentation, nor can the condition possibly be interpreted as resulting from previous crosses with Europeans. In any case, the discovery that the condition depends on a single-gene Mendelian difference from the normal implies both these results.

Now, however, for the biological and evolutionary significance. Not only are these "mutants" (as they clearly appear to be) perfectly capable of healthy existence and reproduction, but they are coming to form a community of their own. The normally-coloured members of the tribe have a feeling against marrying "whites," with the result that the mutants mate almost wholly with others like themselves, and thus in course of time have formed a nearly closed, self-reproducing community of several hundred souls

Mutation: consequent preferential mating: consequent establishment of a definite intra-specific unit: with the future consequence that any further mutation occurring within this unit will remain confined to it, and the difference between mutated and type stock thus become accentuated. Here, in man himself, is a case showing with almost diagrammatic clarity how evolutionary change may originate in single mutations of considerable magnitude. JULIAN S. HUXLEY.

The Marine Biological Laboratory,
Woods Hole, Mass., U.S.A.

Agricultural Research.

THE address delivered by Sir John Russell, as president of Section M (Agriculture), at the recent meeting of the British Association at Toronto, may be characterised as a somewhat despondent survey of present day activities in agricultural research, with particular reference to those branches of the subject allotted to the Rothamsted Station and the special problems upon which the workers there have been engaged. It may be worth while to give consideration to some of the more general aspects of applied research to which Sir John Russell's remarks inevitably direct attention.

When philosophers, as they then called themselves, first turned their attention to the problems presented by the life of the plant, they were not long in finding that the pioneer science of chemistry enabled them to throw an immediate light on what we may now regard as the crude fact, that plant life is dependent for food upon an adequate supply of certain elements, such as carbon, nitrogen, phosphorus, and potassium. It was an easy step to supply some of these elements by "artificial" means. The result was that, dating from the forties of the last century, the practice of applying "artificial" manures received an immense impetus: so much so that farming practice was almost revolutionised. It became possible not only to raise the level of food production from a given area of land, but also to maintain that level indefinitely.

The material consequences of these early discoveries were so great that they created a belief in the efficiency of scientific research as applied to husbandry which has been held to justify the expenditure by the State, as well as by other agencies, of larger sums than have hitherto been devoted to research of any other description. But during the last eighty years science has presented only one other gift of an economic importance equal to that just indicated. Mendel and his belated disciples have taught us to regard the plant as a plastic organisation which can be systematically moulded in desired directions. Sir John Russell has catalogued the remarkable results of the work of Biffen and others.

Yet it cannot be denied that the agricultural sciences have made great advances in other directions in these long years. Our knowledge of the factors concerned in the growth of animals and plants is almost inconceivably greater than it was eighty years ago. Why is it then, that, as judged by economic tests, farming practice has been so little modified that even Virgil's "Georgics" may still be read as a textbook? One reason may be suggested. The growth of a plant or animal is affected by a number of environmental causes beyond human control. A severe hailstorm, a rainy season, may render nugatory all the efforts of the most skilful and scientific husbandman. He earns his living really by virtue of the law of averages. If old tradition is right, he rings a cycle of changes in a lunar period of nineteen years. It is a fair inference, therefore, that he is not likely to be much moved by scientific evidence that a certain course of action will produce a better result *of the order of difference* that he associates with a normal seasonal variation. If, for example, the supposition is made that the yield of any crop on a particular field will vary normally by 10 per cent. from year to year, a scientific improvement, which, if adopted, increases yield by 10 per cent. in any one year, is scarcely likely to interest the husbandman. It may be, therefore, that science has failed to produce discoveries of sufficient magnitude. "Artificial" manuring, it is true, may be said to have been a discovery of the order of 100 per cent; and the science of plant-breeding may be said to have involved differences of the same order.

In Sir John Russell's address, consequently, one detects a feeling of disappointment. We have passed through, he says, a "pioneer period with . . . the disadvantages of certain lack of perspective, failure to follow up important issues, and some narrowness of outlook." He suggests that steps should be taken to secure the co-operation of a team of workers in every science bearing on agriculture—the members to be drawn from all parts of the British Empire. The proposal is scarcely in the region of practical politics. After all, the epoch-making discoveries of science have not come from team work—nor from what is sometimes termed "directed" research.

The Member of Parliament and the Treasury official are apt to think of research as if it functioned like a penny-in-the-slot machine—a mechanism which unfailingly gives "results" for the inserted coin. Such and such an industry should form a Research Association, accept a grant, and forthwith grind out results good for the industry concerned. The whole history of scientific effort, however, is a record of individual successes in so-called "pure" science, and, with due respect to the Director of Rothamsted, what appears to be wrong with agricultural science is that it is too agricultural. If, as he says, the "co-operation of a plant physiologist" is needed, let us take care that the worker is not tied to the study of agricultural plants, and if, in consequence, he is a worker in "pure" botany, let us see that he gets as liberal a grant as his brother working in agricultural botany. At the present juncture, research in pure botany is languishing in all our universities, and yet, on Sir John Russell's admission, the advances made by one branch of the science, that of plant-breeding, have far outdistanced any discoveries in the sciences with which he is directly concerned.

The lesson one may venture to extract from the address of the Director of Rothamsted is that it is high time that the State turned its attention to the need for fostering scientific research in pure science. Directed research, that is, research directed to secure definite economic results, is in danger of becoming outworn for lack of draughts from the *pocula sacra* which University research in pure knowledge exists to provide! CANTAB.

The Vibrations of Air in Organ-Pipes of Unusual Shapes.

IN an interesting letter published in NATURE for August 30, Principal J. A. Aldis discusses the vibrations of air in organ-pipes of unusual shapes, and gives a number of elegant formulæ for calculating the frequencies of the tones in certain cases. The date of the investigations (1867–1868) gives them a special interest, since they were carried out some three or four years before the publication of Rayleigh's well-known paper on "The Theory of Resonance," in which, by the introduction of a quantity which he called the "conductivity" of an orifice, he was enabled to give a simplified treatment of the theory of bottle-resonators and of pipes with restricted mouths.

I was at first somewhat surprised to see that the formula given by Principal Aldis for the frequencies of the tones of bottle-pipes agreed satisfactorily with observations, apparently without any restriction as to the size of the bottle. The formula is obtained by assuming the existence of stationary plane waves in the two parts of the bottle—*i.e.* in the neck (or mouth part) and in the stopped part—and the continuity of the pressures and velocities at the

junction of the two parts. The formula is

$$\tan mh \cdot \tan mk = \frac{\text{area of mouth part}}{\text{area of stopped part}}, \quad . \quad (1)$$

where h is the length of the mouth part, k is the length of the stopped part, and m is $2\pi/\lambda$ or $2\pi n/a$ (n = frequency, a = velocity of sound). While this formula might be expected to be satisfactory in the case of bottle-pipes with parts of moderate length, it would, I think, scarcely be expected to hold good if the length of the bottle were much less than a quarter of the wave-length belonging to the fundamental tone of the bottle. In such a case we should expect to get better results by using Rayleigh's formula for the frequency of a Helmholtz resonator, namely—

$$n = \frac{a}{2\pi}\sqrt{\frac{c}{Q}}, \quad . \quad . \quad . \quad . \quad (2)$$

in which, for a bottle-pipe, c would be the hydrodynamical conductance (Rayleigh's "conductivity") of the mouth part and Q the volume of the stopped part. It appears from this, therefore, that for small bottle-pipes the important factor is the *volume* rather than the *length* of the stopped part.

The point to which I wish to direct attention, however, is that, notwithstanding the apparent diversity of equations (1) and (2), Rayleigh's equation (2) can be obtained as a limiting form of (1) when h and k are made small compared with the wave-length. In this case we have approximately $\tan mh = mh$ and $\tan mk = mk$, and if σ_1 is the area of the mouth part, and σ_2 the area of the stopped part, we obtain

$$m^2hk = \frac{\sigma_1}{\sigma_2},$$

or

$$n^2 = \left(\frac{a}{2\pi}\right)^2 \cdot \left(\frac{\sigma_1}{h}\right)\Big/\sigma_2 k.$$

Since σ_1/h (area divided by length) is the conductance of the mouth part (end-correction being neglected) and $\sigma_2 k$ is the volume of the stopped part, we have

$$n = \frac{a}{2\pi}\sqrt{\left(\frac{\sigma_1}{h}\right)\Big/\sigma_2 k} = \frac{a}{2\pi}\sqrt{\frac{c}{Q}}. \quad . \quad . \quad (3)$$

It appears, therefore, that either of the two forms (1) or (2) may be used for obtaining the approximate frequency of the fundamental tone of a small bottle-pipe. Rayleigh's formula, however, has the disadvantage that it does not help us to discover the frequencies of the overtones.

If in equation (1) we suppose h, but not k, to be small compared with the wave-length, we have the case of a pipe with a narrow mouth. Equation (1) becomes

$$mh \tan mk = \frac{\sigma_1}{\sigma_2},$$

or if $\sigma_1/h = c$ (the conductance of the mouth),

$$\tan mk = \frac{c}{m\sigma_2}, \quad . \quad . \quad . \quad . \quad (4)$$

an equation which was given by Rayleigh in 1871 ("Scientific Papers," vol. i, p. 46, equation (15), the right-hand side is inadvertently shown with a minus sign).

Again, if k but not h is small compared with the wave-length, we have the case of a long tube connected with a reservoir. Equation (1) becomes

$$\tan mh = \frac{\sigma_1}{m\sigma_2 k} = \frac{\sigma_1}{mQ}, \quad . \quad . \quad . \quad (5)$$

Q being the volume of the reservoir. This equation was also given by Rayleigh. E. T. PARIS.

Signals Experimental Establishment,
Woolwich Common, London, S.E.

Abney Sectors in Photometry.

THE following may be of value to those interested in photometry.

The instrument known as the "Abney Sectors" used for reducing, for photometric purposes, the intensity of powerful illuminants, such as searchlight projector arcs, by means of a rotating disc fitted with continuously variable sectors, is difficult to construct, and, unless perfectly made, is liable to stick at high speeds.

I have found the following a simple and efficient instrument.

A disc 12 to 18 inches in diameter, in which curved edged V-shaped slots are cut (Fig. 1), is mounted vertically on a board together with a driving motor. Between the illuminant and the disc, close to the latter, but mounted separately, is a screen in which is cut a small rectangular aperture. The beam of

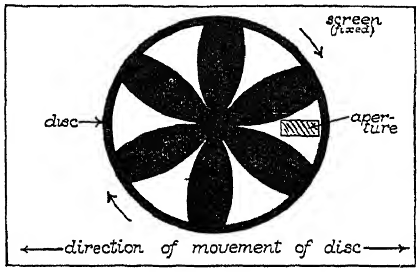


FIG. 1.

light under investigation passes from the source through the aperture and interruptedly through the rotating sectors of the disc to the photometer. The rays are alternately obstructed and allowed to pass by the sectors of the rotating disc, just as in the case of the Abney Sectors. By moving the board on which both disc and driving motor are fixed with respect to the aperture, more or less obscuration as desired may be obtained.

The board may move in a groove graduated to show degrees of obscuration. G. F. WOOD.

Forest Research Institute,
Dehra Dun, July 12.

Aurora, Potential Gradient and Magnetic Disturbance.

IN view of suggestions which have been made from time to time that a relationship may exist between the intensity of the earth's electric field and the phenomena of the aurora, or of terrestrial magnetism, the available data from Cape Evans—the winter quarters of Capt. Scott's last expedition—have been examined. The original intention to make a comparison between the auroral data and the potential gradient data was formed on the publication of the first meteorological volume. This intention was stimulated by the fact that the time of maximum of the daily variation in potential gradient at that station lay between the time of maximum frequency for auroræ (4 A.M.) and the time of maximum magnetic disturbance (10 A.M.)—in time of the 180th meridian. In addition, Dr. Simpson had recorded slight anomalies in temperature and in pressure at the time of day when the aurora was most frequently observed. By the courtesy of Dr. Simpson, copies of the original data for potential gradient were made available, but it was found that the hours during which conditions were favourable both for observations of aurora and for potential gradient measurement (wind less than 10 miles per hour) were not sufficiently numerous to repay investigation.

On the other hand, it is known that the activity of the aurora is related to magnetic disturbance, and data exhibiting this relationship have been published in reports of the Expedition (" Terrestrial Magnetism" and " Observations on the Aurora "). In these circumstances, Dr. Chree kindly lent his original figures for hourly character number (representing magnetic disturbance), and these were used for making a comparison with the figures for potential gradient during winds up to 5 miles per hour, for the period March 1911 to February 1912.

For the purpose of this comparison, the potential gradients corresponding to Dr. Chree's magnetic character numbers (0 = slight and 2 = great magnetic disturbance) have been meaned for all hours during which the wind was not greater than 5 m.p.h. Generally speaking, the mean gradients corresponding to these character numbers vary during the course of the day similarly to the curves shown on p. 315 of " Meteorology," vol. i. The mean value for the year corresponding to

Character number 0 is 89 volts/metre.
,, ,, 1 is 90 ,,
,, ,, 2 is 96 ,,

Taking, however, means for each hour of the day, and allowing equal weight to each hour, the corresponding numbers are 88, 89, and 91. The evidence seems, therefore, to be against any direct connexion between magnetic disturbance and potential gradient at this station.

Figures have been derived for the mean value of the potential gradient at each hour of the day, for four periods of three months each, and these figures also do not encourage much hope in the reality of such a connexion. The mean values for the four quarters (commencing for convenience in February, and equal weight being allowed to the mean value for each hour of the day) are :—

Quarter.	Magnetic Character Number.		
	0	1	2
Feb to Apr.	82 (82)* volts/metre	81 (83)*	88 (88)* volts/metre
May to July	77 (76) ,,	77 (78)	78 (78) ,,
Aug. to Oct.	93 (93) ,,	93 (94)	93 (96) ,,
Nov. to Jan.	106 (111) ,,	98 (99)	107 (107) ,,

* The figures in brackets represent the corresponding means when each observation during the quarter is given equal weight.

C. S. Wright.

Wey Lodge, Portmore Park,
Weybridge.

A Substitute for the McLeod Gauge.

The letter in Nature of August 23, p. 276, fails to justify an attack on the McLeod gauge. The theory that water is absorbed by glass is a theory only, of which there is no proof, and there is no proof that the McLeod gauge reads incorrectly or even that it is inconsistent. Any variation can be observed only by comparison with another method of measuring low pressure, which is just as likely to vary or be inconsistent as the McLeod gauge. Animal emanation, the glass-blower's breath for example, is very difficult to dislodge from the surface of glass and might easily cause a disturbance in the electric spark phenomena.

A final pressure of 0·001 mm. is mentioned; this means a pressure which will support a column of *mercury* 0·001 mm. high. The McLeod gauge is the only practical means of determining this measurement directly.

In a former letter we were told that the McLeod gauge may have special uses (such as the calibration of other gauges) " under rigidly controlled conditions." This can only mean clean glass, pure mercury, and an efficient drying medium, but it goes to prove my assertion that " there is no substitute for the McLeod gauge, in its perfect measurement of low pressures, expressed in height of mercury column."

Henry A. Fleuss.

47 Albert Road,
Caversham, Reading,
September 4.

Mr. Fleuss's letter answers itself. But may we trespass on your space for the last time in order to correct a misunderstanding which others than Mr. Fleuss have shared, and for which our original letter was doubtless responsible?

We never intended to deny that the McLeod gauge, used rightly, is a thoroughly trustworthy instrument and almost indispensable for the calibration of all other gauges, except possibly the Knudsen. But we deny that, as it is often used, it is trustworthy or convenient. It is still, or was recently, an almost universal practice to attach a McLeod to every pumping system and to take readings on it a few minutes after the apparatus has been exposed to the air, and long before the condensed water is removed from the glass. McLeod gauges used in such circumstances are, we repeat, " cumbrous and misleading devices," " mere relics of the past." They are responsible for the ridiculous underestimating of pressures which is still common in the papers of serious investigators. It is for gauges used in such circumstances that we advocate the Pirani gauge as a substitute. Its increasing use shows that we are not alone in our opinion.

N. R. Campbell.
B. P. Dudding.
J. W. Ryde.

Chimæras Dire: Transplantation of Heads of Insects.

I am sorry that Prof. Przibram (Nature, September 6, p. 347) should think that I treated Dr. Finkler's statements with unbecoming levity. The object of my letter was simply to direct attention to Dr. Blunck and Dr. Speyer's criticisms of Dr. Finkler's work and not to express agreement with one side or the other. Now that Prof. Przibram has undertaken to reply to these criticisms, the accuracy of my brief summary is perhaps no longer a matter of great importance, although I fail to see that it is in any way seriously misleading. It is true that I ought to have written " thorax " instead of " wing-cases," and also that Dr. Finkler has not yet told us with what he fed his inter-specific monsters; but I still think that the sentence " a male head led a female body into unwonted perversities " is not an unfair version of what Dr. Finkler has said. To those of us who have only a scanty knowledge of the subject it seems a less extraordinary thing that " the male head kept its usual reaction towards the female . . . when transplanted to a body of opposite sex " than that the body should acquire a new reaction as a result of the operation.

The complaint that Dr. Finkler had refused to submit his specimens for investigation by others was not mine, but was made, as I stated, by his German critics. The specimens which Mr. Boulenger brought to London have been repeatedly exhibited here. I was told that they were not to be submitted to dissection or section-cutting, but I am now informed that no such condition was imposed by Dr. Finkler in handing over the specimens.

W. T. Calman.

British Museum (Natural History),
London, S.W.7.

Biology and Religion.[1]

By Prof. J. S. HALDANE, F.R.S.

FOR religion the world, whether visible or invisible, is the manifestation of God. The real basis of religion lies in our own conscious experience, in our awareness of values which determine the course of our existence and unite us all but cannot be regarded as derived from either individual or collective self-interest. In so far as we realise these values, their objective reality, and their unity, we acknowledge, whether we are aware of it or not, that our universe is a spiritual universe and the manifestation of one God.

The theories of natural science seem to recognise neither objective ethical values nor God. Yet many scientific men have been deeply religious, and in one way or another have, even though often unsatisfactorily, reconciled their science with their religion. With the progress of science in recent times such reconciliation has seemed to become more and more difficult, and the existence of spiritual reality in the sense implied in religion has seemed to become more and more shadowy. During the nineteenth century this process was very marked; and it was particularly the progress of biology, and only to a minor extent that of historical criticism, that brought the difficulty to a head. I shall endeavour in this paper to indicate what seems to me the cause of the difficulty, and to maintain at the same time that however uncompromising the attitude of biology is, and I hope always will be, towards obsolete details of theological creeds, there is in reality nothing to come between biological science and real religion.

Perhaps we can best realise the cause if we call to mind the argument of a once popular book, Paley's "Natural Religion." Paley argued that, first, the human or animal body is a piece of exquisitely perfect machinery; and that, secondly, the existence of this wonderful machinery is clear evidence of the existence of a superhuman Designer. His argument was not very original, but it was at any rate put with great clearness. The first step came to be accepted by the great majority of physiologists; but the second step was invalidated by the discovery of evolution and the theory of natural selection. It is, however, to the first step that I wish to direct attention; for the essence of the whole matter is there.

Granted that the body is a machine, Paley would have said that the soul is placed within to control its voluntary working. Nevertheless, the more the matter has been investigated the more clearly has the fact seemed to emerge that the conscious control of the machine is dependent on exactly the same sort of material conditions as its ordinary unconscious working. We need only, for example, reduce the oxygen supply, or cut off the supply of some substance supplied by a gland, to produce not only loss of normal conscious control, but also a condition akin to, or identical with idiocy. If, therefore, the body depends upon mechanical conditions, so also does the mind or soul. Moreover, moral and mental characters are just as clearly transmitted by ordinary generation as bodily characteristics. In Paley's time, and indeed for long afterwards, many physiologists believed that there is active in the living body a factor which they called vital force, which is independent of the mechanical conditions. But the observations just quoted are fatal to vitalism also.

Paley's first step, taken in conjunction with the further development of physiology, thus leads us straight towards what is called materialism. Consciousness becomes a mere mysterious accompaniment of mechanical processes; and spiritual values have ultimately no more meaning than they can have in a purely physical world.

Paley was a product of his time. With his generation, and succeeding generations, he accepted the assumptions about the nature of visible physical reality which had come down to him from Galileo and Newton. These assumptions were that visible reality consists of self-existent bodies separated from one another in self-existent space and time, and acting on one another according to the definite laws of mechanics, physics and chemistry. The human body, as a part of visible reality, must be just as much subject to these laws as inorganic bodies.

But Newton's conclusions about visible reality were based on the observation of inorganic phenomena. They seem to fit these phenomena, or at least seemed until recently to fit them, though Newton himself was far from thinking that he had done more than make a beginning of applying them in detail. But do they fit the phenomena of life? If they do not, then Paley's first step was a false one, and the materialistic conclusions which have so naturally grown out of it fall to the ground. From the purely scientific point of view of biology itself, the question is fundamental. No one can doubt that the conception of a living organism as a mechanism such as Paley depicted is to a very large extent useful and convenient; but is such a conception consistent with the characteristic phenomena of life and conscious behaviour? To this scientific question I have largely devoted myself since my student days.

If we observe the relation between physiological stimulus and response we find that, under standardised or "normal" conditions of environment, the response follows the stimulus as regularly as any physical effect follows its cause. But when the conditions of environment are altered, perhaps to only a very slight degree, this is no longer the case: the response is altered, perhaps totally prevented or "inhibited," to use a physiological term. The exact response of a limb, for example, to a stimulus, say a visual stimulus, acting on the body, depends on a host of stimuli varying in nature with the relative positions of the various parts of the body: depends also on endless other co-existent stimuli, whether visual or of other kinds. It is just the same with chemical stimuli acting on any part of the body whatsoever.

When we regard this phenomenon from a wider point of view, we see that we can with very considerable success predict what happens if we assume that the life of an organism is something which actively asserts and maintains itself, including the organism's relations to its environment, in a manner which is specific or "normal."

[1] From a paper read at the Conference of Modern Churchmen, at Oxford, on August 28.

The responses and their modifications or inhibitions then fall into intelligible order. Apart from this assumption, characteristic physiological responses are nothing but unintelligible chaos: we cannot predict the characteristic manner in which stimuli and responses become associated and effective.

That the parts and activities of a living organism exist relatively to one another is evident. The very nomenclatures of biology presuppose this. Relativity reigns supreme in biology. But not only is this so: the relationships of life also actively assert and maintain themselves. The responses of the nervous system become intelligible from this point of view; but this is still more evident in connexion with the simpler responses within the body to molecular stimuli—the responses connected with respiratory exchange, assimilation and secretion. It is with these responses that my own experimental work has been mainly associated, and the study of them has left no doubt in my mind of the necessity for regarding the already defined conception of life itself as fundamental in biology.

Perhaps this necessity will become more easy to understand if I refer to the basis of practical medicine on its therapeutical side. When the organism is injured by any passing cause, tissues of exquisite delicacy have been destroyed or altered in structure. We have no means of repairing or replacing these structures as we might repair or replace the injured parts of a machine. Nevertheless, the injuries can be healed, and by various means we can facilitate the process or render it certain. It is because life actively maintains and reproduces its normals that recovery is brought about. What a doctor does is merely to aid Nature in the process. Any other view of the matter amounts to the mere quackery which has been repudiated by scientific medicine ever since the time of Hippocrates.

But I can almost hear some well-meaning scientific colleague saying "Your conception of life may be all very well as a sort of heuristic principle, but it is totally unintelligible. The process of healing and reproduction must depend on a series of molecular reactions; and the right way to understand it is to investigate these reactions one by one. Since the living body is material it must be subject to the laws of all material action. In other words, it must be a mechanism, though a very finely balanced and complex molecular mechanism." Let us then suppose for the moment that this is so, and see how the assumption works out.

The living body reproduces itself from generation to generation. In the process of reproduction it grows from a microscopical speck, or rather two microscopical specks, the male and female elements, which have united to form one. Little or none of the assumed molecular machinery can exist in these specks: it must all be gradually built up again in the course of development. This development itself is a very complex process, which on the mechanistic theory would necessitate the existence of extraordinarily complex molecular machinery in the germinal specks, and corresponding machinery in the parent organisms for producing the germinal machinery. The mind recoils from the incredible complications involved.

Specific germinal cells in the bodies of animals can sometimes be followed in their successive divisions from one generation to another, and in this sense there is continuity of the germ-plasm. On the mechanistic theory, therefore, the molecular machinery of reproduction reproduces itself by fission from its like. But how is a delicate piece of machinery to reproduce itself by fission? Imagine the unspeakable confusion in such a process, or in the sexual union of two similar pieces of machinery!

I have perhaps said enough to show why I cannot regard the mechanistic theory of life as tenable. It involves quite impossible assumptions and leads us nowhere in respect of the characteristic phenomena of life. Not only the newspapers, but also scientific men, continue to speak of the mechanism of life and heredity: I confess that such an expression has no meaning whatsoever to me. We cannot dispense with the distinctive conception of life. Let there be no mistake, however, about what this implies. It implies that the old conception of visible reality which Galileo and Newton set forth has broken down; and that there is no use in appealing to that conception in support of a mechanistic theory of life. Life would be unintelligible on that conception; but it is reality that science has to deal with, and not an ideal world of mechanism. The ideal mechanical world of Galileo and Newton corresponds sufficiently well for most practical purposes with our experience of inorganic phenomena, but does not correspond with our experience of biological phenomena. The supposed self-existent bodies and separable reactions of the ideal mechanical world have turned out to be not really self-existent and separable; and we have to modify our fundamental conception of visible reality accordingly, though for many practical purposes the merely mechanical conception may suffice.

It may be many years before the significance of the phenomena of life for our conceptions of visible reality is generally understood; but assuredly this general understanding will in time be reached.

So far I have only discussed life in such a form as we seem to meet with in plants, or in the activities of parts of our own bodies which we assume to be unconscious. I now come to conscious activity. We know what conscious action is in ourselves, and we can easily infer its presence or apparent absence in other persons. We can also form some judgment as to its presence in even lowly organised animals.

Conscious is distinguished from unconscious experience or activity by the fact that a conscious experience or action carries with it an ordered reference to both past and anticipated experiences, as well as to other present experiences. It was Kant who first pointed out this fundamental fact clearly in relation to perception. A conscious experience not carrying in itself ordered relations to past and anticipated experience is a purely imaginary figment. This discovery constitutes the great advance which Kant made beyond Berkeley and Hume. We cannot derive our conceptions of the spatial and temporal orderliness of our world from separate experiences of it: the orderliness is already given in any experience, and belongs to it. An ordered universe existing apart from conscious experience of it would be nothing to us. It was to a world of relativity that Kant's analysis of perception led.

At first sight Kant's idealism seems to lead us into impossible or practically unmeaning conclusions; but let us follow the same line of reasoning further than

Kant followed it. He belonged to his own time. The order which he found to be implied in conscious experience was simply the order of the physical world as pictured by Galileo and Newton; and indeed his idealistic philosophy became a sort of buttress to their ideas of visible reality. Whether visible reality was self-existent, or relative, or ideal did not seem to matter much in practice, although with relativity physics Kant's reasoning has now come into prominence among physicists themselves.

When we examine our own conscious experiences and actions we find that they hang together in another manner besides those pointed out by Kant. They hang together or are essentially related in the manner already described in connexion with the phenomena of life. Whether we will or no, they influence and inhibit one another in a manner which cannot be predicted or understood on merely physical principles, and which only becomes more or less predictable or intelligible in the light of the conception of life. What Locke called the secondary qualities in experience come under this category, together with various natural appetites and instincts, repulsions and attractions. Into all our conscious perceptions and actions this element of relatedness enters, and not merely the relatedness in a physical sense, to which Kant directed attention. Both in connexion with ourselves and with other organisms is this true. It is only by a process of artificial abstraction that we can neglect the biological aspect of our conscious experience, and the neglect of this aspect has led to endless intellectual confusion.

We must not make the mistake of supposing that the conception of life stops short at the body-surface of an organism. A living organism cannot be separated in thought from its environment. In life the physiological relation to environment is maintained just as clearly as the physiological relation between the parts of the body. An organism belongs to its environment just as much as its parts belong to one another. Different individual organisms are also organically related to one another, by parenthood, sex relations, and mutual association of various kinds. The normal limits in duration of individual life are also an apparent evidence of this relationship.

In consciousness of the biological aspect of experience, and in corresponding conscious action, our lives have for us a past and future which is inseparable from the present. Our perceptions and actions are thus those of conscious interest, as distinguished from the blind immediacy of what we regard as mere biological phenomena. Our world is a world of interests and values, and our actions have a corresponding responsibility attached to them.

The existence of biological phenomena showed us that a mere mechanical conception of visible reality is fundamentally inadequate, however useful practically for some purposes. The progress of philosophical investigation since Descartes has also shown us that in whatever way we may for temporary practical purposes represent to ourselves the visible universe, it cannot be in reality anything but a universe of conscious existence. Berkeley, Hume, Kant, and their lineal successors have been in agreement about this, however short they may have stopped in the further development of their conclusion. Putting together this conclusion with the previous one, we find that our universe is a universe of perceived interests and values, and of responsible conduct.

Let us now examine further the nature of the interests and values which present themselves in perception and conscious behaviour. We can think of them in the first place as the interests of an individual human organism. In the life of a conscious organism, what is required for the maintenance of its normal organic life and structure is foreseen and provided for in the light of past experience, since conscious experience and action reach out, as Kant showed, into both the past and the future. In this process the environment is as much concerned as the body of the organism itself, since life, when we investigate it, involves, and indeed manifests itself in, a normal relation between living organic structure and environment. This fact is to some extent masked in higher organisms, which, as Claude Bernard first indicated, possess, in the form of their blood, an internal environment which by various means is kept amazingly constant in its character, and acts as a sort of buffer between the living tissues and the variations in the external environment; but now that physiologists have become aware of this, the true relations between organisms and environment are standing out ever more clearly. It is a relationship which can only be comprehended as an organic one: a merely physical interpretation of it is not possible. Even from the point of view of our merely individual lives, our environment is in no mere physical relationship to us: it is bone of our bone and flesh of our flesh.

An isolated individual human organism is, however, only a scientific abstraction: for without at least a mother or nurse no human infant could survive. In the perception more particularly of human relationships and corresponding actions, we become aware of wider interests than those centred round our individual organisms. The wider interests centre round family, countrymen, the human race, and extend also to animals, plants, and country. They extend also to both the past and future. In the experiencing of them it is just reality itself that is being revealed to us; and spiritual reality, not merely ideal scientific abstractions. We are, in fact, no mere self-centred beings, complete in ourselves; and those who set before themselves, and endeavour to act on, the idea that they are entirely self-centred are only doing violence to their own nature.

This latter conclusion seems to me equally clear even if we simply regard human behaviour from an abstract biological point of view. A higher organism is an assemblage of countless individual cells; but the behaviour of not one of them is intelligible biologically apart from its relations to the rest, and to the environment generally. In exactly the same way the biological behaviour of individual human organisms is unintelligible apart from their relations to other human organisms and the rest of their environment. Their very being in the biological sense manifests itself in this relationship. We belong in the most intimate sense to our environment.

The wider interests which reveal themselves in human society have a compelling power which dominates what we regard as mere individual interests. In these wider interests we meet with something which we can in this sense describe as "not ourselves," though in another

sense it is the reality of ourselves. It binds us together in spirit, so that what others feel and see we also feel and see. We thus attain to what we regard as objective perception, a perception that others share in, and that unites all men: also to corresponding objective standards of behaviour.

This perception and behaviour is not just the collective or average perception and behaviour of a number of individuals, but something which only shows itself in fellowship with others, and in the contemplation of our relationship with Nature. It is the manifestation of the spiritual Reality of our universe—the Reality which men call God.

We are so accustomed to regard reality as physical reality in the sense of Galileo and Newton that any more adequate conception of reality seems to us far away and unreal—mere mysticism. We are the children of a materialistic age. We look for a soul consisting, if not of ordinary matter in the mechanical sense, yet of something which is only a thinly veiled imitation of it. We look, also, for a similarly constituted God. Such entities can never be found. God is with us, in us, and everywhere around us, as Jesus taught. We must learn to see spiritual reality, and not the mere appearances of matter. We must learn, also, that the voice of God is not a voice threatening us from outside with material punishments or coaxing us with the hope of material rewards, but a voice which, when we hear it, transforms our most hidden motives and thoughts.

Let me return to the relations of biology and other branches of natural science to religion. Perhaps it might seem that what I have been saying attributes to natural science the responsibility of blinding us to spiritual reality. Are not, for example, Galileo and Newton, and the great biologists who have treated the living body as if it were a piece of mechanism, responsible in this respect? To point out that theologians are equally responsible does not answer this question. I wish to consider it directly.

When we examine the original contributions of great men of science we always find, first, that on the data before them their conclusions were justified, and, secondly, that these conclusions were calculated to be of great practical use to their fellow men. If it is true that the reality of our universe is spiritual, it is no less true that we are constantly struggling with illusion and imperfection, and that it is only in that struggle that spiritual reality manifests itself to us. We cannot separate faith from works. The motive of science has always been the discovery of what, in one way or another, will be of use; and at every turn we make use of scientific discovery in practical affairs. It does not matter how limited in scope the discovery may be, we can always make use of it. To take examples, the discoveries by Kepler of the mechanism by which images are focussed on the retina, or by Harvey of a mechanical process by which blood is circulated through the body, were limited in scope, but of immense practical service. The eye cannot be regarded as a mere mechanical structure, nor the circulation as a mere mechanical process, so there is a reality beyond these discoveries. This does not, however, detract from their value, any more than the discoveries of Einstein have detracted from the value of Newton's discoveries.

Scientific investigation is just part of the struggle in which spiritual reality manifests itself; and the realisation of this brings science, particularly pure science, very near to religion. It is only when science becomes dogmatic that it assumes an attitude which seems to deny the existence of spiritual reality. We find very little of this dogmatism in the writings of great men of science, but much more of it in the desiccated science of systematic text-books and popular expositions. For example, the idea is spread abroad in such writings that natural science, unlike philosophy, advances by a steady process of addition. We have only to look back on the history of natural science to see how utterly misleading this idea is. The progress of science is just as much strown with the remnants of discarded theories as is the progress of philosophy; but, in spite of this, continuity of development is evident in the histories of both of these subjects. Surely it must be the same with theology.

During most of my life I have been struggling more or less with scientific dogmatism, but I have never before addressed an audience mainly clerical. I wish to take the opportunity, therefore, of adding my voice to those of others who are engaged in struggling with the shackles of theological dogmatism. There are very many who, like myself, are kept away from existing churches by creeds and church services which they cannot honestly countenance, and perhaps a still larger number who are actively hostile because they regard churches as hotbeds of superstition. If I thought that my country could get on equally well without churches I should not care what was taught in them. But I do not think so. We need to be constantly reminded of that spiritual reality which manifests itself in willing service of every kind, and without the perception of which our country would relapse into chaos.

The churches cannot afford to be hampered by unintelligible beliefs which are mainly materialistic accretions of Christianity and greatly weaken its influence on those who are worth influencing. Religion itself stands on ground which cannot be assailed: it has no use for rickety defences. The story of Jesus and His teaching appeals to all men, and influences them practically, because it touches what is deepest and most real in them. Many, however, feel forced to conclude that that teaching was based only on emotional illusion. Hence adequate philosophical or theological support is needed for it. This support should be based on the widest philosophical and scientific knowledge. Any shirking of the questions involved, or cowardly sheltering behind mere traditional authority, is fatal. The true function of a church is to help men to see reality as a whole, and to guide their actions accordingly, thus preventing social chaos, intellectual confusion, and artistic decay.

You are members of the national Church of England, and we are meeting near the spot where one of the greatest leaders of that Church, a man of English yeoman stock, met his end. It is to Latimer that my mind goes back when I appeal for intellectual freedom in the English Church. He stood, not only for social justice and humanity in his country, but also for intellectual freedom. It was not of his own sufferings, or his own soul, that he spoke as he was dying, but of the England he had served so fearlessly, so lovingly, so faithfully, thus finding oneness with God.

The candle which was lighted in England as Latimer and Ridley perished is still burning.

The Forces which lift Aeroplanes.[1]

By Prof. V. K. F. BJERKNES, Geophysical Institute, Bergen.

THE forces which carry aeroplanes are now subject to intensive experimental and theoretical investigation. In one respect, however, these investigations have led to a surprising result, namely, that the force which makes flying possible belongs to a group of forces discovered long ago, before the period of aviation. Their existence had been predicted mathematically, and these predictions had been verified by experiments.

THE DIRECT GEOMETRIC AND THE INVERSE DYNAMIC ANALOGY BETWEEN HYDRODYNAMIC AND ELECTROMAGNETIC FIELDS.

This old theory, and these old experiments, relate to what is called *hydrodynamic actions-at-a-distance*. The period when the doctrine of action-at-a-distance was absolutely predominant lasted, at least on the Continent, until about thirty years ago. The researches which I am about to describe, date from that period. My father, C. A. Bjerknes, could not reconcile himself with this doctrine at the time when he was a student at the University of Christiania, about eighty years ago. Ten years later he had the opportunity of acquainting himself with recent results of research in theoretical hydrodynamics. These had just led to a surprising fact: a spherical body could move through a frictionless fluid without experiencing any resistance. This paradox was in his eyes an important fact in discussing action-at-a-distance. The doctrine of Newtonianists had been that space was empty. They believed that a medium filling it would ultimately stop every motion. But this argument now turned out to be erroneous. The supposition that space was filled with a medium was not contradictory to the first axiom of dynamics, the principle of inertia. This made another idea occur to him: Should not the same medium be able also to propagate actions from body to body, thus giving rise to apparent action-at-a-distance? And would not the answer be found by solving the problem of simultaneous motion of two or more bodies in the fluid—for mathematical simplicity of spherical or cylindrical form?

The conditions under which my father worked were not favourable. But he never gave up his point of view, and twenty-five years later he was in possession of the full solution of the problem, and had verified the results by a series of striking experiments.

The result was that a very remarkable analogy became evident between the field of motion in a fluid and the electric or magnetic field of force: the bodies produced fields of motion of precisely the same geometric structure as static or stationary electric or magnetic fields. Moreover, they exert apparent actions-at-a-distance upon each other, equal to, but—most curiously—opposite to the actions-at-a-distance between the corresponding bodies in the electric or magnetic fields.

GENERAL STATEMENT OF THE ANALOGY.

In one respect, however, my father's theory was special: he had proved this analogy to exist only for bodies of spherical or cylindrical form. By slightly changing the problem, I succeeded some twenty years ago in giving an absolutely general proof of the analogy. I retained in my theory the idea that the main fluid was homogeneous and incompressible. But for the solid spheres and cylinders I substituted *fluid* bodies of any shape. These bodies may differ from the surrounding fluid in four respects: (1) In density: this gives the body a reaction against acceleration, different from that of the surrounding fluid; (2) in compressibility: the bodies may perform motions of expansion and contraction; (3) the motion considered was allowed to be vortical inside the bodies, while it was always irrotational in the surrounding fluid; (4) external force may act upon the elements of the bodies but not on those of the surrounding fluid.

The advantage of considering the entire system as fluid is that its dynamics are then determined completely by the hydrodynamic equations. Therefore the analogy to the electric or magnetic field may be demonstrated by a simple—in reality very simple—transformation of these equations. The leading idea of this transformation is to consider the actual fluid field of motion as made up by two partial fields: the *impressed field*, which is that produced by external force, including the hydrodynamic actions-at-a-distance; and the *induced* or *free field*, which is due to fluid pressure, setting aside that part of the pressure which produces the hydrodynamic actions-at-a-distance. The impressed field exists only inside the bodies, while the induced or free field pervades all space, including that inside the bodies, and when added to the impressed field in this inside space, it gives the actual fields of motion of the bodies.

This system can be compared with an electric or magnetic one. Specific volume will then correspond to magnetic permeability or specific inductive capacity; velocity will correspond to magnetic induction or electric displacement. The product of velocity into density, that is, specific momentum, will correspond to magnetic or electric intensity. Impressed field within the fluid bodies will correspond to impressed field in the interior of a permanent magnet or a pyro-electric crystal, and induced hydrodynamical field will correspond to induced magnetic or electric field in external as well as in internal space. Velocity of expansion or of contraction will correspond to magnetic or electric charge, positive or negative; and vorticity, specially defined here to be the curl of induced specific momentum, will correspond to electric current density.

This correspondence between the quantities used for describing the two kinds of fields being agreed upon, the analogy between the two kinds of fields may be stated thus:

At any moment the field of motion of the fluid system is identical in geometrical structure with a certain static or stationary magnetic or electric field; and in this hydrodynamic field there are apparent actions-at-a-distance which, element for element, are equal but opposite to those of the corresponding forces of the magnetic or electric field.

Having obtained this theoretical result we can easily apply it to solid bodies; for the external force which we have introduced is subject to no restriction. We can

[1] From a discourse delivered at the Royal Institution on Friday, May 9.

therefore let this force, or a certain part of it, control the motion of a body in such a way that it moves as if it were rigid, or solidly elastic. This result is attained by imagining reciprocal actions between the particles of the body which have no resultant for the entire body. The only thing to be taken into account will be the impressed fields produced by these reciprocal actions between the particles. But as these fields are characterised by small motions in all possible directions, they will in general give rise only to insignificant reactions with the exterior field.

By substituting solid bodies for the fluid bodies we can obtain experimental demonstrations. But, it may be argued, where solid bodies are moving in a fluid we do not in general observe any striking analogy with the phenomena of the electric or magnetic fields. The reason for this is twofold. First, to recognise the analogy we must divide the field into its impressed and induced parts. The distinction between these two partial fields will not in general be visible to the eye. It must be found by a dynamical analysis. Secondly, the hydrodynamic system is a moving system which is always changing its configuration, and the direction and intensity of motion of its different parts. During each new phase of its motion we must therefore compare it with a new electromagnetic system: this gives a fugitive character to the analogy. But in two cases it must crystallise into a concrete and strikingly visible form: first, when the motion is permanent, and secondly, when it consists of small synchronous oscillations about an invariable average configuration. In both cases we have to compare it with a constant electric or magnetic field. In both cases the induced hydrodynamic field is hidden as a more or less invisible field, while that part of the impressed field which is due to the hydrodynamic actions-at-a-distance produces strikingly visible effects.

This result is, however, obtained in both cases at the expense of a certain reduction of the extent of the analogy. As vortices cannot be oscillatory in a frictionless fluid, they must be zero. In the oscillating case, therefore, the analogy with the electric currents fails. On the other hand, as displacement of the boundary surface would violate the permanence of the motion, all phenomena due to change of volume or of place of the bodies drop out; and we retain only the phenomena depending upon permanent circulation, corresponding to those of electric currents.

THE INSTRUMENTS.

A general auxiliary instrument is a generator for producing vibrating motion. A little electric motor drives a spindle having two eccentrics, each of which works a little pump. Each pump is double-acting and consists simply of cylinder and piston but has no valves. Through the outlet tubes communicating with the ends of the cylinders a few cubic centimetres of air is thus alternately driven out and in, in opposite phases from the two ends of the same cylinder. A cock allows us to regulate the amplitude of that oscillating air current which is conveyed to the main instruments. When a unidirectional air current is desired, a simple valve arrangement may easily be inserted.

A practical peculiarity of the instrument is that the cylinders, not the pistons, are connected with the eccentrics, and that the pistons react against the motion only by their inertia. This proves useful in connexion with the regulation of the amplitudes. Cylinder and piston are carefully polished but *never* oiled. Another peculiarity of construction is an elaborate symmetry of the moving masses and of their motions, in order to eliminate all vibration of the instrument by compensation.

The alternating air currents from the generator are used to produce two kinds of vibration: first, pulsations, or periodic changes of volume, and secondly, oscillations or periodic changes of place. The pulsating body is a drum having metallic membranes (by their durability preferable to indiarubber membranes) and fixed on the end of a metal tube (Fig. 1, I, II). The membranes are alternately blown out and sucked together by the alternating air current. Loading one membrane of such a pulsator, and connecting the other membrane with a spherical shell, which is mounted on a tube and surrounds the pulsator, we get an oscillator (Fig. 1, III): the outer shell and the inner load make opposite oscillations. The desirable case when these become equal amplitudes is attained when the weight of the load equals the sum of the weight of the spherical shell and the half of the mass of water displaced by it. In this event the pulsator will, by the principle of the conservation of the centre of gravity, remain at rest, and the outer shell will oscillate undisturbed both when the projecting tube of the pulsator is taken in the hand and when it is inserted in a rigid clamp. It will not transfer disturbing oscillations to sensitive balances in which it is inserted for the experiments.

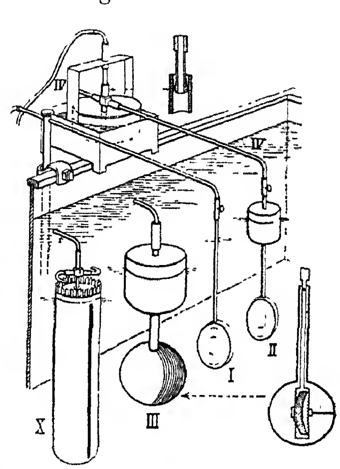


FIG. 1.—Balance arrangement with pulsators (I, II), oscillator (III), rotating cylinder (X).

Different arrangements can be made for giving such a pulsator or oscillator the degree of mobility required for examining the forces or couples exerted upon them. It is generally convenient to let it float with a buoy. If then the tube conveying the air from the generator is sufficiently flexible, we have at once both translatory and rotatory mobility. To reduce the mobility to a pure translational one, we may give the system of tubes which convey the air from the generator the form of a torsion balance. The weight of this balance is conveniently carried by a floating buoy, swimming in the tank used for the experiments, or in an extra vessel outside it, to reserve the main tank exclusively for the bodies under experiment. We may also do away with the torsion tube of this balance, and let the air go directly from a fixed tube through a loose joint into the balance with really very little loss of air (Fig. 1, IV). This has the advantage that the equilibrium is always indifferent. One of these balance arrangements may be used for demonstrating the attractions, repulsions,

or lateral displacements exerted upon a pulsating or an oscillating body. The latter may be inserted in the balance in two principal ways: for longitudinal mobility, so that its direction of mobility coincides with its axis of oscillations; or for transverse mobility, so that the direction of its mobility is normal to its axis of oscillation. Rotational mobility of an oscillator is obtained either by suspending it by a rubber tube, or by letting the air pass direct into the floating oscillator through a loose joint.

As bodies having no vibrating motion of their own, we use a heavy sphere suspended from a float, a light sphere held under water by a load and suspended from a float, a light and heavy cylinder suspended in the same way.

Finally, for studying the field of motion set up in the fluid we may use a simple arrangement, namely, a light spherical body attached to an elastic wire. This sphere will be set into induced oscillations by the surrounding fluid, and, choosing that period which gives resonance, we can magnify the minute water oscillations and make them visible. The sphere may also carry a light rod which projects above the surface of the water, and carries a pencil which inscribes its oscillations automatically with ink upon a glass plate placed above the water.

These instruments serve for experiments with vibrating bodies. Permanent motions can be produced by the rotation of cylindrical bodies. By a simple valve arrangement inserted in the tubes conveying the air current from the generator, the alternating current may be changed into a unidirectional one. This current can then be used to drive a turbine attached to a cylinder which is thus set into rotation (Fig. 1, X). To examine the forces exerted upon such a cylinder the latter is placed in the balance just as the pulsator or oscillator was, while another cylinder driven in the same way is mounted on a handle which may be taken in the hand or fixed in a support.

(*To be continued.*)

Obituary.

SIR WILLIAM BAYLISS, F.R.S.

"BAYLISS'S book is by far his greatest contribution to science—much more important than any of his individual discoveries is his statement of his point of view." These were substantially the words used to me by a very competent critic. At the time I wondered whether or not it were so, and I have often wondered since. Bayliss's investigations into the electric phenomena of the heart [1] and the salivary glands,[2] into the conditions which govern the cerebral circulation,[3] into the muscular movements of the alimentary canal,[4] into the mechanism of vaso-dilatation,[5] into the correlation of vaso-motor reflexes;[6] his establishment of the existence of antidromic fibres in the mammal,[7] his researches on the application of surface phenomena to physiological action,[8] and the discovery of secretin [9]—these were his principal discoveries.

When all allowance has been made for the fact that most of this work was carried out in collaboration, it remains an extraordinary tribute to a man's point of view to say that the statement of it transcends such researches. Yet in support of my friend's statement I reflect that in another continent there are "Bayliss Clubs"; these do not exist for the study of the specific subjects enumerated, but for the joint discussion by physiologists and chemists of so much of science as they have in common. The association of Bayliss's name with such societies is a tribute precisely to Bayliss's statement of his point of view. It is not merely that when one asked why the clubs were so called one received the answer, "We discuss the sort of thing which is in Bayliss's book," but that when one comes to think the matter out, one finds it not a little surprising that such societies were not associated with other names; for it cannot be claimed that Bayliss was a pioneer in the investigation of biochemistry. His interest in the subject—so far as may be gleand from his published works—dated from about the comemencement of this century—before which date the pioneer work in Great Britain had been done. Hardy had launched colloid chemistry in the 'nineties; Hopkins, before the eighteen hundreds were complete, was well forward with that series of isolations which adorn both organic chemistry and physiological science; and Halliburton had done the major portion of his work.

Bayliss's great contribution was that he discussed the whole subject of biochemistry as a continuous whole, thinking out each point *ab initio*, and committing the record to paper, so that what he thought for himself he thought also for others. His method of approaching a subject was one which lent itself admirably to this procedure. The quality of genius differs from individual to individual, probably even more than its quantity. Among scientific men, the genius of some is of the artistic type; though possessing great certainty of touch their inspiration comes they know not whence. To the onlooker it appears almost to be an accident; that it is not so is proved by the fact that it crops out too often in the life of the same person. In others genius is of the mathematical type; with them the premises are grouped in a particular way and to their vision the conclusion flashes out.

Bayliss's genius was not precisely of either type—at least if my own appreciation of it may be trusted. He took nothing for granted, he was not in a hurry, he inquired with meticulous care into every step of an argument; if he found something which was not perfectly clear to him, he spared no pains to discover whether the thread of the argument was really broken or whether he had merely failed to follow it. In the end his mind became clear on the subject; to his own satisfaction he was able to pronounce either that he understood the matter and that it was thus, or that he failed to understand it because the thread, to the best of his judgment, was not continuous.

Such a method is eminently calculated to exclude all forms of obscurantism, and indeed nothing was more

[1] *Journ. of Physiol.* 12. xx, 1891, and 13. lviii. 1891.
[2] *Journ. of Physiol.* 7. 217, 1886.
[3] *Journ. of Physiol.* 18. 334, 1895.
[4] *Journ of Physiol.* 24. 99, 1899.
[5] *Journ. of Physiol.* 16. 10, 1894, and 24. 173, 1901.
[6] *Journ. of Physiol.* 37. 264, 1908.
[7] *Journ. of Physiol.* 28. 276, 1902.
[8] Proc. Roy. Soc. B, 84 229, 1911, and 91. 196, 1920.
[9] *Journ. of Physiol.* 28. 325, 1902, and 29. 174, 1903.

foreign to Bayliss's philosophy than vague talk about "vital force" or the like. Either a phenomenon was understood, in which case the explanation could be written down and placed on record in his book, or it remained for investigation. In the latter case it might fall into one of two categories, (*a*) that of being capable of explanation on the basis of current knowledge of the properties of matter, (*b*) that which awaited further discoveries into the fundamental conditions which govern material things. It was Bayliss's good fortune to be at the zenith of his intellectual powers at a time when important additions were made to the knowledge of several departments of chemistry and physics, such, for example, as of adsorption, of catalytic action, of interfacial phenomena, and of radiant energy. Each successive addition afforded to Bayliss a prospect of the removal of phenomena from category (*b*) (above) to category (*a*), and of their final elimination from the region of the unexplained. That was Bayliss's point of view—as I understand the matter; it was a point of view extremely stimulating to the student, not only because it led so directly to experimental investigation, but also because it led along a road which seemed so straight and so easy to follow.

Could Bayliss have been given the choice as between a spectacular form of genius on one hand and a form which was readily intelligible on the other, I feel sure he would have chosen the latter. The spectacular had little attraction for him; simplicity was characteristic no less of his intellectual outlook than of his personal habits.

I gladly concede to rising generations that to them Bayliss's statement of his point of view is his most important work, but to myself Bayliss—of course in conjunction with Starling—was pre-eminently the discoverer of secretin. The moment when the first drop of pancreatic juice was elicited by the injection of duodenal extract must, I think, have been the most dramatic in his scientific career. Possibly I take this view, because I was at a peculiarly impressionable age at the time, possibly it is accentuated because of a trifling incident which stamps it upon my mind. I had the good fortune to witness, not indeed the first successful experiment on the subject, but I think the second—that in which the first was to be either confirmed or refuted. The physiological laboratory at University College, London, was in those days peculiarly open to young physiologists—I imagine that it is not less so now. Some errand took me round there: the door of Bayliss and Starling's room was open: an experiment was in progress. Bayliss held a flask in one hand, and with the other was in the act of introducing a tissue extract into the circulation from a burette, Starling was on his haunches, his eye on the level of a canula which projected from the animal: the extract went in: the blood pressure fell for the nonce: there was a pause and then—drop, drop, drop from the canula. There was no secrecy—all was explained without reserve, to a youngster who had published perhaps a couple of papers, who hailed from another laboratory, whose very presence might have been accounted an intrusion, and who had no possible claim on either the confidence or the genius of those who had made so great a discovery. Thus can generosity and understanding attract youth within the charmed circle of genius.

Indeed, Bayliss loved the company of the young. I can see him now discussing some topic with a circle of young, and, it may be, obscure physiologists, at the meeting of some society, and by his simplicity and sympathy wiping out the disparity in age and status, or lunching off porridge in a popular restaurant surrounded by young researchers and wishing for no more elaborate fare and no more exalted company.

Bayliss took a considerable interest in public affairs—scientific, sociological, and political—probably in that order. Under this heading mention should first be made of his work in connexion with the Medical Research Council; for the following information I am indebted to Sir Walter Fletcher. From the historical point of view the Medical Research Council came into being at a time when the practise of medicine in Great Britain had much to gain from a closer liaison with physiological discovery—a fact which was greatly emphasised by the War, and one which afforded to Bayliss a field of peculiar usefulness in connexion with the work of the Council. The most conspicuous work which Bayliss did during the War will always associate his name with the subject of surgical shock, for the fuller understanding of which the Council appointed a very strong committee over which Bayliss presided; his own contribution was principally on the side of treatment. His introduction of intravenous injections of gum saline not only was regarded by many competent authorities as being of great use, but also it paved the way for a renewed interest in blood transfusion and a much improved technique for the purpose.

After the War, Bayliss assisted the Medical Research Council by presiding over a Committee for the investigation of the biological action of light, the object of "which is to analyse, explain, and extend all our valuable but still quite empirical knowledge of the action of light on the body, as in increasing its defence against tuberculosis, raising the bacteriological power of the blood, and in replacing and facilitating the action of vitamin A." Bayliss greatly assisted in suggesting precise laboratory observations. This work is still in progress, and in its concluding phases his loss will be greatly felt.

Much of Bayliss's work was of a surgical type; and, probably rather by accident, he was singled out at one time as the special target of those who disapproved of animal experimentation—a rather singular irony, because he was always on the side of the weak, the struggling, and the oppressed in all movements designed to better their condition. In politics he was a Liberal and presided over a local organisation of the Liberal party.

Bayliss's sociological interests became more evident towards the end of his life. The last man to derive any satisfaction from seeing his name in print, he was a frequent contributor to the press in the form of letters on such subjects as he thought might be helpful. This was part of his "statement of his point of view," though in a minor sphere; where he found difficulties he recorded them and gave the record to all and sundry who might be helped by it. On scientific matters he was a frequent contributor to NATURE, whilst his sociological writings embraced subjects so widely separated as the importation of cocaine, the methods of killing meat for food, and the desirability of birth

control. Indeed, he was a vice-president of the Society for Constructive Birth Control and Racial Progress.

Bayliss received the honour of knighthood in 1922. He held the following degrees and distinctions: M.A. and D.Sc. (Oxon.), Hon. LL.D. (Aberdeen and St. Andrews), F.R.S., Hon. Fellow of Wadham College, Oxford, Hon. member of the Danish Academy of Science, Corresponding Member of the Société de Biologie (Paris) and of the Royal Academy of Belgium, Professor of General Physiology, University College, London, member of the Council of the Royal Society, 1913–1915, secretary and afterwards treasurer of the Physiological Society, Joint Editor of *Physiological Abstracts* and of the *Biochemical Journal*. Bayliss delivered the Croonian Lecture to the Royal Society in 1904 and received the Royal Medal in 1911, the Copley Medal in 1919, and the Baly Medal of the Royal College of Physicians in 1917. He delivered the Oliver-Sharpey Lectures in 1918, the Sylvanus Thompson Lectures in 1919, and the Herter Lectures in 1922.

JOSEPH BARCROFT.

AN appreciative account of the scientific career and work of Dr. T. C. Mendenhall, who died on March 22, is contributed to *Science* of July 11 by Mr. G. R. Putnam, and we are indebted to it for the following particulars: Dr. Mendenhall was born on October 4, 1841, and after preliminary training as a teacher, became the first professor of physics in the Ohio State University. He went to Japan in 1878 as professor of physics in the Imperial University at Tokyo, and three years later returned to Ohio. He was president for several years of the Rose Polytechnic Institute, and for seven years of the Worcester Polytechnic Institute, from which he retired in 1901. Dr. Mendenhall took a leading part in many activities connected with science and engineering in the United States. He was for five years superintendent of the Coast and Geodetic Survey, and served as president of the American Association for the Advancement of Science, and the American Metrological Society. He carried out some notable investigations in terrestrial gravity, seismology, atmospheric electricity, and related subjects.

WE regret to announce the following deaths:

Mr. F. H. Bradley, O.M., fellow of Merton College, Oxford, and author of "Appearance and Reality," "Principles of Logic," and other authoritative works on problems of philosophy, on September 18, aged seventy-eight.

Prof. Alexander Darroch, professor of education in the University of Edinburgh, aged sixty-one.

Dr. Franz Doflein, emeritus professor of zoology and comparative anatomy in the University of Breslau, on August 26, aged fifty-one.

Dr. J. Elliott Gilpin, professor of chemistry at Johns Hopkins University, known for his work on the action of chlorides of phosphorus on amides and on fractionation by capillary diffusion of crude petroleum, aged fifty-seven.

Dr. Sidney Martin, F.R.S., physician to University College Hospital, London, and distinguished for researches in chemical physiology and pathology, on September 22, aged sixty-four.

Current Topics and Events.

A FINE, seated statue of Lord Lister, in academic robes, the work of Mr. G. H. Paulin, was unveiled in Kelvingrove Park, Glasgow, adjoining the University, on September 17, by Sir Hector C. Cameron, Dean of Faculties. The Lord Provost presided, and speeches setting forth Lord Lister's unique service to humanity in the domain of scientific surgery were made by Sir Hector, Sir Donald MacAlister, Bt., principal of the University and president of the General Medical Council, and Prof. J. H. Teacher, of the Royal Infirmary Department of Pathology, who is the custodian of the Lister relics there preserved. It was in the Kelvingrove Park, near his house, that Lister meditated the principles of his antiseptic method of wound treatment, during his tenure of the University chair of surgery from 1860 until 1869. It was in the Royal Infirmary, near the old College, that he applied these principles to practice, and thereby demonstrated their efficacy in the prevention of suppuration and of septic poisoning in operative wounds. The ceremony was preceded by a luncheon in the Civic Chambers, attended by a large number of distinguished surgeons and citizens of Glasgow, and by Mr. J. J. Lister, fellow of St. John's College, Cambridge, and nephew of Lord Lister. The latter spoke of his uncle's early researches, and of his private life, in response to the toast of the Lister family, proposed by Sir Donald MacAlister, who narrated some picturesque incidents of his friendship with Lord Lister during thirty years. The statue completes the effort begun by the Glasgow Lister Memorial Committee in 1912, but interrupted by the War. Generous contributions have been made by it, not only to the Glasgow monument, but also to the international fund for establishing a Lister Oration and Prize for research in surgery, to the memorial in Westminster Abbey, and to the Lister collections displayed in the Glasgow Royal Infirmary in commemoration of the great surgeon's association with the institution.

THE announcement in the daily press regarding the decision of the Government to provide a "further" sum of 500,000*l*. for agricultural education and research deserves, perhaps, some elucidation. It may be recalled that the Development Commissioners hold two funds—the old and the new. From the old come such charges as the grants to the various Agricultural Research Institutes established before the War and the salaries and expenses of the advisory officers attached to University Agricultural Departments. The old fund, also, has to meet the cost of what may be termed the miscellaneous statutory activities of the Commissioners in relation to fishery, harbours, etc. To the new fund, on the other hand, being the creation of the Corn Production (Repeal)

Act, is debited the cost (in England and Wales only) of certain schemes which escaped the fall of the Geddes axe. As to finance, it would appear that the old fund is kept alive by annual doles from the Treasury, whereas the new fund, starting with 850,000*l.* in 1921, has now received a windfall of a further sum of 500,000*l.* In a communiqué recently issued by the Ministry, it is announced that the new money will probably be allocated in part to the schemes relating to research on foot and mouth disease; economic research; marketing investigations; veterinary education and research; soil surveys; and the National Institute of Agricultural Botany. It is also announced that, in relation to the new money, no definite allocation of funds as between Scotland and England has been made. From this explanation it would appear that the Corn Production "New" Fund of 850,000*l.* is earmarked for expenditure in England and Wales only.

ANNOUNCEMENT has been made of the retirement on September 30 of Dr. Crichton Mitchell from the service of the Meteorological Office, in which he has acted for some years as general superintendent of the activities of the office in Scotland. He was originally appointed from May 16, 1916, to be Superintendent of the Observatory at Eskdalemuir, on the recommendation of the Gassiot Committee of the Royal Society. That committee is responsible for the administration of the Gassiot Trust Fund, the most notable of the few private endowments for geophysical subjects in Great Britain, and on the transfer of the administration in 1910 of the Observatories at Richmond and at Eskdalemuir from the National Physical Laboratory to the Meteorological Committee, it accepted the responsibility also of nominating superintendents of the three observatories attached to the Meteorological Office at which geophysical work was undertaken, namely, Kew, Eskdalemuir, Valencia. At the termination of his first year, Dr. Crichton Mitchell was reappointed for the duration of the War or longer if it were necessary. The appointment so begun has continued for eight years and a half with great advantage to the observatories and considerable enlargement of their scope. The work now includes the climatological work taken over from the Scottish Meteorological Society in 1913 and the expansion of the meteorological station at Lerwick into a geophysical observatory, when certain buildings became available there after the War, as well as the work on daily weather at Scottish stations for the Air Ministry. Dr. Mitchell brought to his task the enthusiasm for physical science engendered in the University of Edinburgh in the time of Tait, Crum Brown, and Chrystal, the practical experience of managing an observatory at Trivandrum, and the administrative experience of the educational department of Travancore. That he should have been available for developing his special gifts of organisation in Scotland just in the dark days of the War must be regarded as an example of good fortune for the geophysical sciences, which otherwise labour under considerable disadvantages.

THE *Morning Post* has discussed recently the question of why "science does not pay." It is true that in many cases technically trained men fail to make much direct use of the knowledge they acquire at college in their subsequent life. But we know that the scientific training they have undergone has indirectly often been of the greatest value to them. We are not impressed by the fact that sometimes a municipality offers a beggarly salary for a technically trained assistant. Unless the prospects are good, there is little chance of a suitable man being obtained. Young men like posts where there is a chance, even if only remote, of ultimately getting a lucrative and influential position. For this reason they are content to receive a less salary than a mechanic of the same age would be allowed by his Trade Union to accept. Even a Covent Garden porter demands a guaranteed minimum of 4*l.* 5*s.* per week, whilst many technically trained men accept readily initial salaries less than this. A junior engineer in works, even although he has had works experience, often begins on a less salary than the minimum given in the Burnham scale for secondary school teachers But capable men have good chances of promotion to better posts, and if they are enthusiastic for their profession, they do not grumble even when promotion seems remote. The remedy for unemployment is the development of national resources, and this calls, as Prof. J. A. Fleming says in a letter to our contemporary, for new ideas, initiative, and invention. Many manufacturers are fully alive to this fact, and we think that nowadays they all hold science in high esteem. In the engineering profession, there is a demand both for young men of the public school type, that is, men who get on well with manual workers, and for thoughtful men who love research and invention. A young honours graduate in science with works experience has little difficulty in getting a post in the electrical engineering profession. We think that the chances of promotion compare very favourably with other professions. It has been suggested that the Engineering Institutions look after the remuneration of their members and are simply glorified Trade Unions. This is not the case. They were founded for the advancement of science and its applications, and only enforce regulations on those engaged in any advisory or consultative capacity.

CERTAIN of the delegates attending the International Congress for the Protection of Nature held in Paris at the end of June 1923, felt that the object desired could be better effected by means of a smaller and more permanent organisation. An informal conference was therefore held at the Natural History Museum on November 2, at which it was decided that the Society for the Promotion of Nature Reserves should summon a meeting of organisations in Great Britain interested in the protection of animal and plant life, the promotion of Nature reserves, and kindred objects. The meeting was held at the Natural History Museum on January 14, under the chairmanship of Viscount Ullswater, and as the outcome the Central Correlating Committee for the Protection of Nature was set up, and it is believed

that similar committees will be formed in other countries. The constituent organisations of the British Committee and their representatives are as follows: The Trustees of the British Museum, Lord Rothschild (chairman); British Ornithologists' Union, Maj. A. G. L. Sladen, Entomological Society, Mr. W. G. Sheldon; International Committee for the Protection of Wild Birds, Mr. Hugh Gladstone; Linnean Society, Sir Sidney Harmer; National Trust for Places of Historic Interest and Natural Beauty, Mr. E. G. B. Meade-Waldo; Royal Society for the Protection of Birds, Mr. F. E. Lemon; Society for the Preservation of the Fauna of the Empire, Maj. Stevenson Hamilton; Society for the Promotion of Nature Reserves, Earl Buxton; Zoological Society of London, Dr. P. Chalmers Mitchell. Dr. G. F. Herbert Smith, Natural History Museum, S.W.7, is the Honorary Secretary-treasurer.

THE new Anglo-Dutch telephone cable which connects Domburg, Walcheren, on the Dutch coast, with Aldeburgh has been successfully laid. The length of the cable is 86 nautical miles. Pupin coils are not used, but each of the sixteen conductors is continuously "loaded" with iron wire. The British Post Office and the Dutch Telegraph Administration are to be congratulated on having such well-founded faith in mathematical theory. Through such a long length of cable, speech would be hopelessly distorted were it not for the loading. Another novelty is the use of paper instead of gutta-percha or ballata for the dielectric. This reduces the leakage and lowers the electrostatic capacity, both highly desirable results As strong tides and currents prevail in the Channel and North Sea, substantial armouring in addition to two lead sheaths are employed. To obviate the necessity of having to make numerous joints, the cable was constructed in ten-mile lengths, and the s s. *Faraday* was fortunate in having calm weather during the process of laying the cable. The weight of the cable exceeds 2000 tons, and Messrs. Siemens Brothers and Co. had to build a special shop and erect new machines in order to make it. The tests show that the cross-talk between the core circuits and between a physical and its associated "phantom" circuit were less than the minimum specified. It is hoped that a good telephone service between Britain and continental countries will foster trade and promote better political relations.

THE electrical transmission of photographs has been an accomplished fact for some time past, and the principle involved is simple. A very small pencil of light passes through the surface of a cylinder and impinges upon a photo-electric cell at its axis. The negative to be transmitted is wrapped round the cylinder, and as the latter revolves with a fine screw-like movement, every part of the negative passes in turn between the light pencil and the photo-electric cell and regulates the current according to its density. The receiver at the other end of the wire consists of a cylinder that revolves synchronously with the sending cylinder, and is covered with a sensitive photographic film upon which impinges a very fine pencil of light after it has passed through a "light-valve" which allows light to pass through it of an intensity that is regulated by the transmitted current. It is but a step from the sending of a simple photograph to the transmission of the three colour-records of a colour photograph. This we learn from the Colour Supplement of the *British Journal of Photography* for September has recently been successfully done at the instigation of Mr. S. H. Horgan over a line about a thousand miles long, namely, from Chicago to New York. Mr. Horgan made a three-colour lantern slide from the records as received, and says that the Western Electric Company were "amazed at the beautiful and faithful colours shown in the slide."

IN connexion with the British Empire Exhibition, the British Dyestuffs Corporation, Ltd., has published an illustrated booklet which tells the story of the discovery in 1856 of the first artificial dyestuff by W. H. Perkin, who was then but eighteen years old, and of the subsequent vicissitudes and successes of the dyestuffs industry in Great Britain. Within twenty years of that chance discovery, Germany had taken the lead among the dye-producing nations, and Great Britain was importing 80 per cent. of her requirements from continental sources. The decline and fall of British initial supremacy in this field has been attributed to many causes, but the author of this pamphlet is convinced that neglect of research was the most potent. The renascence of the industry during the War, the energy and resourcefulness of the firms that had survived foreign competition, the establishment of the Corporation about five years ago, and the reversal of the 4 : 1 ratio of imports to home manufactures, are events and achievements too recent to have been forgotten by the scientific world, but their reiteration from time to time to those who can with difficulty understand the fundamental importance of a vigorous organic chemical industry is both useful and necessary. It is interesting to note that since its inception the Corporation has expended 450,000*l.* on research; that it now employs 125 chemists, 83 per cent. of whom possess high university degrees, 30 colourists, about 30 engineers, and approximately 3000 workpeople. The five factories owned by it occupy 600 acres of land, and consume annually 80,000 tons of coal, 30 million units of electricity, and 2000 million gallons of water. Facts like these speak for themselves.

DURING recent years the Government of Great Britain has been increasingly active in instituting measures for dealing with the diseases and pests of cultivated plants and crops, and J. C. F. Fryer and G. H. Pethybridge (*Journ. Min. Agric.*, July 1924) have drawn up a useful historical summary and résumé of the present position of the phytopathological service of England and Wales. In the early years, after the passing of the Privy Council orders against the Colorado potato beetle in 1877, all research and advisory work was dependent upon the efforts of individual scientific workers. No official service was organised until the passing of the Development and

Road Improvement Funds Act, 1909, which provided resources for a definite scheme of research investigation and advisory work in agricultural and horticultural plant pathology. This service has developed into two distinct, but co-ordinated, organisations, one consisting of a body of Government officials under the direct control of the Ministry of Agriculture, and the other of a number of scientific workers in the various universities, agricultural colleges, and research institutes, financed from Government funds, but free from the detailed instructions of the Ministry and subject only to a certain amount of supervision to secure efficiency. The résumé indicates the subdivision of the work among the various units of these two sections. Diagnosis of diseases and pests in the field is the function of a corps of advisors, and investigations into fundamental problems such as those relating to the physiological action of insecticides and the nature of immunity and resistance to disease are carried on by the research workers in various institutions. The official body deals with the collection and distribution of information, the practical work of administering existing legislation with regard to diseases and pests, and the control of plants coming into or exported from Great Britain. Although each part of the service is independent, an increasing degree of co-operation exists in dealing with problems of all types, thus enabling more rapid and efficient progress to be made.

A period of frequent rainfall, which has prevailed over the British Isles since the commencement of April, is dealt with in the *Meteorological Magazine* for September by Mr. C. E. P. Brooks, of the Meteorological Office. The rainfall is given for the period of five months, April to August. The percentage of the average rainfall, 1881–1915, is given for different parts of the British Isles. The excess is least in Scotland, where for the five months it amounts to 126 per cent. of the average. In Ireland it is 131 per cent., in England and Wales 146 per cent., and for the British Isles generally, 138 per cent. of the average. For the south-east of England the fall is 161 per cent. of the average, and in each month with the exception of June the percentage of the average rainfall is greater in the south-east of England than in any of the larger divisions of the British Isles. The five months in question are said to have proved a decidedly rainy period, although not excessively so; the rains were chiefly cyclonic. Details are given showing the influence of travelling Atlantic depressions on the weather of the British Isles, an inquiry which some day may yield data to assist in long-period forecasting.

The Chinese floods are somewhat explained in the *Meteorological Magazine* for September. The floods are referred to as unparalleled in the present century. It is stated that in the province of Chih-li 25,000 square miles are under water, and it is estimated that nearly five million people are homeless. The water is 3 feet higher than in the flood of 1917, when the material damage was estimated at 25,000,000*l*. Between Tientsin and the Shansi Mountains is the meeting ground of five rivers, and a great quantity of silt is brought down from the mountains; this raises the level of the river bed. The waters are greatly restrained by embankments, and if a gap is broken a river may flood a wide area of the country. The average rainfall is about 20 inches a year, which falls almost entirely in the three summer months July–September. This summer the rainfall has been abnormally heavy; at Pekin, the fall in July was 26 inches, and at Tientsin 32 inches fell in three weeks. These heavy rains have broken numerous gaps in the banks, causing disastrous floods over all the low-lying country. The meteorological situation favouring floods in North China is dealt with, and reference is made to an article in the *Times* of September 2, which alludes to definite plans having been prepared after the disaster of 1917 to avert the danger of similar floods.

It is announced in the *Observatory* that Prof. H Kopff, of the Heidelberg Observatory, has been appointed professor of theoretical astronomy in the University of Berlin and Director of the Astronomischen Recheninstituts.

A director of the Norfolk Agricultural Station is required. Candidates for the position must possess a university degree or diploma, a modern scientific training in agriculture, first-hand experience of arable agriculture, organising ability and facility in lecturing. The latest date for the receipt of applications, which should be sent to the Secretary, Norfolk Agricultural Station, 11 Bridewell Alley, Norwich, is October 11.

An assistant is required in the British Museum Laboratory for research in connexion with the cleaning and restoration of museum exhibits. Candidates must be honours graduates in chemistry, with research experience and a wide general knowledge of chemistry, with, if possible, training in mycology and an interest in archæology. Applications for the post should be sent, upon a prescribed form, not later than October 11 to the Secretary, Department of Scientific and Industrial Research, 16 Old Queen Street, S.W.1.

Applications are invited for positions under the Ceylon Government of a mycologist and a systematic botanist. The first named, if a senior officer with tropical experience, will be placed in charge of the mycological division; the second will be required to take charge of the systematic work in the Botanic Gardens of the Colony, to make researches into the flora of Ceylon, and to study especially the ecology of Ceylon plants. The posts will become vacant about July next. Applications must be made upon a special form obtainable from the Private Secretary (Appointments), Colonial Office, S.W.1.

The Secretary of State for the Colonies has appointed a committee to advise him on matters relating to the recruitment and training of officers for the agricultural departments of the non-self-governing dependencies. The committee will be constituted as follows: Lord Milner (chairman), Lord Lovat (vice-chairman), Sir Arthur Shipley, Sir Daniel Hall, Prof. J. B. Farmer, Dr. A. W. Hill, Mr. F. B. Smith, Major R. D. Furse, with Mr. P. A. Clutterbuck, of the Colonial Office, as secretary.

A GENERAL discussion on the physical chemistry of igneous rock formation is to be held in the rooms of the Geological Society, Burlington House, London, on Wednesday, October 22, beginning at 3 P.M. The meeting is being organised under the joint auspices of the Faraday Society, the Geological Society, and the Mineralogical Society. A general introduction will be contributed by Dr. J. S. Flett, and papers are expected from Prof. C. H. Desch, Dr. J. W. Evans, Prof. J. W. Gregory, Mr. A. F. Hallimond, Prof. Paul Niggli, Dr. A. Richardson, Dr. A. Scott, Mr. G. W. Tyrrell, and Dr. W. E. S. Turner. Further particulars relating to the meeting may be obtained from Mr. F. S. Spiers, 90 Great Russell Street, London, W.C.1.

THE Educational Number of the *British Medical Journal* (September 6) contains an article by Dr. Andrew Balfour on the teaching of public health, in which he reviews approvingly the provisions of the new regulations for the Diploma of Public Health, introduced by the General Medical Council on January 1 this year. The medical practitioner can now obtain the Diploma only after he has been qualified for two years and the period of study extends over one year. Dr. Balfour also details the provisional scheme of lectures and practical work of the new London School of Hygiene and Tropical Medicine, of which he is the first Director. The London School of Tropical Medicine has just been incorporated in this new School, the buildings for which will be ready in about two years' time and are being built and equipped by the generous gift of two million dollars by the Rockefeller Foundation. An account of the circumstances of the foundation of the School appeared in NATURE of July 28, 1923, p. 149.

Our Astronomical Column.

NEW COMET, 1924 *c*.—A comet of the eighth magnitude, with a tail, was discovered by Mr. Finsler at Bonn on September 15. The following positions have been received, the first two being approximate only:

G.M.T.	R.A.	N. Decl.	Place
Sept. 15·27	13ʰ 13ᵐ 0ˢ	19° 0′	Bonn.
17·27	13 35 0	16 0	Bonn.
19·276	13 52 8	12 7	Babelsberg.

From these the following orbit has been deduced, but as the observations are not exact, it may be considerably in error:

$$T = 1924, \text{ Sept. } 4{\cdot}15 \text{ G.M.T.}$$
$$\omega = 67^\circ\ 9'.$$
$$\Omega = 87^\circ\ 46'.$$
$$i = 114^\circ\ 48'.$$
$$\log q = 9{\cdot}5940.$$

The following positions are calculated from these elements, for Greenwich midnight:

	R.A.	S. Decl.	log *r*.	log Δ.
Sept. 28.	14ʰ 50ᵐ 44ˢ	1° 13′	9·8660	0·0801
Oct. 2.	15 7 36	5 33	9·9095	0·1190

SOLAR PHYSICS AT CAMBRIDGE.—The eleventh annual report of the Director of the Solar Physics Observatory at Cambridge, covering the period April 1, 1923–March 31, 1924, has just been published. The bulk of the work accomplished falls under the three headings—stellar work, solar work, meteorological physics. Under the first heading come the very valuable theoretical investigations of Messrs. E. A. Milne and R. H. Fowler, by means of which they have given more precision to the method devised by Prof. M. N. Saha of calculating stellar temperatures and pressures from the degree of ionisation of atoms in the atmospheres of the stars. Furthermore, stellar data, in the light of modern theory, have now been made available for the solution of certain physical problems. On the experimental side, Mr. Baxandall has identified certain absorption bands in the spectra of S-type stars with bands of zirconium oxide—an identification which has since been confirmed by Mr. Merrill at Mount Wilson. The chief solar work of the year, other than routine observations, has been the systematic examination of flocculi by Mr. Butler, and the study, by the Director and Mrs. Beech, of areas and proper motions of sun-spots in the light of the Mount Wilson discovery that the true sun-spot cycle covers a period of 22 instead of 11 years. Mr. Moss has examined the daily records obtained at Kodaikanal of the distribution of prominences at the sun's limb for the years 1904–1922, and has obtained interesting indications of loci on the sun's surface specially favoured by prominences. The correlation of the phenomena of sun-spots, flocculi, and prominences has thus been the outstanding solar work of the observatory. On the meteorological side, Mr. C. T. R. Wilson has continued his investigations of ionising radiations by the "cloud" method, while Dr. E. V. Appleton has been investigating the changes of potential gradient due to very distant lightning discharges, which are regarded as the sources of the disturbances known as "atmospherics" in wireless telegraphy.

RADIATION AND MASSES OF STARS.—Prof. H. Vogt describes an investigation into the relation between the masses of a number of double stars in the *Zeitschrift für Physik* of August 8; he deals with 85 double stars from the Lick Observatory Bulletin, No. 343, and others which have been considered by Eddington. The masses were calculated from the absolute brightness and the temperature as determined from the spectrum, using Eddington's formula, and thus the mean ratio between the masses of the brighter and fainter components was determined for different spectral classes (bright component).

The following table shows the result, M*b*/M*f* being the ratio of the mass of the bright to that of the faint component, S the spectral class of the bright component, and *n* the number of stars considered:

Giants.			Dwarfs.		
S	M*b*/M*f*	*n*	S	M*b*/M*f*	*n*
M	18·4	2	A	1·6	9
K	2·7	6	F	1·3	23
G	1·9	9	G	1·25	18
F	3·0	5	K	1·23	11
B	4·6	8	M	1·19	2

If one double star is left out from the five F giants, M*b*/M*f* for this class becomes 1·7, and then, with the exception of the B giants, the ratio diminishes towards unity as the state of development of the stars progresses, as would be the case if the mass diminished with the radiation. Assuming that when a brighter component is in the A (dwarf) class, its mass is 2·5 and the mass ratio M*b*/M*f* is 1·6, and that both components diminish in proportion to the radiation output, then if M*b* has the values given below, in passing through the later spectral classes, the values of M*b*/M*f* are as given in the third line, and may be compared with the values of M*b*/M*f* above:

	A	F	G	K	M
M*b* . .	2·5	1·5	1·0	0·7	0·4
M*b*/M*f* .	1·6	1·2	1·10	1·06	1·04

Research Items.

English Gypsy Burial Customs.—Mr. T. W. Thompson continues his interesting study of gypsy burial customs in the Journal of the Gypsy Lore Society, Third Series, Vol. III., Pt. 2. Although burials in unconsecrated ground are recorded, the evidence does not on the whole support the view held by some that this was, at one time, the normal practice. In the Heron family, however, only one burial appears in parish registers between 1650 and 1830. The most characteristic funeral rite of the English gypsies was the sacrifice of all the belongings of the deceased which were not buried with the body. The tent and surplus clothes were burnt, possessions which could not be burnt were buried, and the horses and donkeys were sold to gorgios or, in earlier days, were killed. In some cases the living wagon was burnt, even when the deceased was not the owner but only a member of the family, or a child. The reason would appear to be fear that the dead would be restless and jealous at others using their property rather than a dread of pollution, though this may not be entirely absent. In like manner the objects buried with the dead and the offerings made at the grave, though possibly in some degree intended for his service, were primarily to protect the living by making him happy and contented. This dread of the return of the dead is also shown by the avoidance of the names of near relatives no longer living. If another relative or friend bears the same name, a fresh name or nickname is used. Although to swear by a dead relative is the most solemn oath a gypsy can use, a descriptive phrase is substituted for the name. Gypsies also avoid camping places used by the deceased, and, more commonly, abstain by vow or otherwise from his favourite drink, food, or amusement.

Iron Working in the Cameroons.—In *Man* for September, Mr. L. W. G. Malcolm gives an account of iron-working in the Bagam area of the Cameroons. Trades are here under the direct control of the head chief and are specialised, a tradesman being a privileged person and exempt from all work other than his own. Each trade is a guild to which a limited number of apprentices is allocated. No stranger is allowed to enter an iron-smelting hut without a ceremony which includes aspersion of the stranger and the sacrifice and eating by the workers of a fowl purchased by him The furnace, which is housed in a low hut, differs from the usual West African type in being built in a pit with a sloping approach It appears to be a development of the Kordofan type, but is much larger. It is square in horizontal section with a back of the natural ground, the sides and front being of clay mixed with chopped grass. The charging hole is on the top between the two sets of bellows, which are arranged on the solid earth at the back, and the gas escape tube Each bellows has a tuyère, of which the lower end rests on the fire-bed inside the furnace. When the furnace has been lit and charged, which is done gradually, it is kept in full blast by relays of blowers for twenty-four hours. The amount of metal produced at each reduction is about sixty pounds.

The Ancestors of Man.—In a popular article contributed by Prof. Henry Fairfield Osborn to the June number of *Asia*, he emphasises his belief that the Tertiary ancestors of man will be discovered in the high plateau region of central Asia. He therefore looks forward with eager anticipation to the results of the new expedition which has been sent by the American Museum of Natural History to collect fossils in Mongolia. Prof. Osborn asserts that "the arboreal theory of man's origin has been given up," and adds that "his ancestors, if tree-living, left their trees in the middle period of the Age of Mammals." He considers that man was driven to live in caves in western Europe by the advance of the ice sheet and the consequent cold conditions during part of the glacial period. It was an episode "of vast importance in the mental and spiritual development of the race, just as the previous period of life in the open was one conducive to its physical and moral development." He thinks that man lived in the open for a comparatively long period, the oldest known race being represented by the flint implements and fireplaces discovered in the Pliocene Crag of Foxhall, Suffolk. Prof. Osborn's article is written to counteract the influence of Mr W. J. Bryan, who has lately published many attacks on the doctrine of organic evolution, and seems to have a large following in the United States of America.

The Stifling of Silkworm Cocoons.—In the Bulletin de la Société d'Encouragement pour l'Industrie Nationale for June, M. G. Bertrand describes how extremely sensitive the chrysalides of the silkworm are to the vapour of chloropicrin. The shell in which the chrysalides are naturally enclosed does not protect them appreciably from attack by the vapour, which ensures a complete and rapid stifling of the cocoon. One gram of this agent per 1000 gm. of cocoons acting for one hour at 20° C. will effect the desired result, even if double cocoons are present. On exposure to air, the cocoons lose practically all odour of chloropicrin and dry readily. The stifling produced in this way, which is equal and sometimes even superior to that secured in the usual "dry and humid heat" industrial processes, does not affect the silky envelope, the colour and other original qualities of the cocoons being retained. Neither do the spinning qualities decline. The tenacity and elasticity of the fibres obtained by the new and old processes are found to be the same. The author emphasises the fact that the new method is, both from the academical and industrial points of view, economical, and requires less supervision, since the margin of safety, without fear of damage to the silk, is very considerable. It is claimed that the chloropicrin process is convenient and certain, has no objectionable action on the silk, and requires no complicated or costly installation.

Protozoan Parasites of Oligochæte Worms — The freshwater Oligochætes have long been known to harbour a variety of interesting protozoan parasites. The study of these has lately been taken up by Dr. Doris L. Mackinnon and Miss D. Ines Adam, who contribute two important papers on the subject to the *Quarterly Journal of Microscopical Science* (vol. 68, Part II.). The first of these deals with the life-history of the remarkable genus Triactinomyxon, a genus so complex in its structure and development that it has been doubted whether it is really a Protozoon at all The peculiar triradiate "spores," with their thread-capsules, so similar to those of the Cœlenterata, are described and figured, and an admirably clear and straightforward account of the life-history is given, with copious illustrations. Most of the known species of the genus occur in the common Thames worm, Tubifex, and the authors' account is based chiefly upon a new species, to which they have given the name *Triactinomyxon legeri*. The second memoir deals with four astomatous Ciliates parasitic in the genera Tubifex, Nais, and Lumbriculus. The authors remark that if a really satisfactory classification of the astomatous Ciliates is ever to be made, it

is necessary that many more of the earliest recorded forms should be re-investigated and re-identified, and their work forms a noteworthy contribution to the subject.

ALKALOIDS FROM DATURA.—The Bulletin of the Imperial Institute (vol. 22, p. 134) contains the results of analyses of *Datura metel*. It appears that if the flowers of this plant are removed during cultivation so that no fruits appear, the yield of alkaloids is increased from 0·24 to 0·36 per cent., the former figure being obtained for normal fruiting plants. Further, the alkaloid present consists almost entirely of scopolamine in deflowered specimens, while in normal plants only about one-fifth of the alkaloid is scopolamine, the remainder being hyoscyamine.

NORTH AMERICAN SPECIES OF ARISTIDA.—Mr. A. S. Hitchcock has described (Contrib. U.S. Nat. Herbarium, 22, 1924, p. 517) the North American needle-grasses of the genus Aristida. These grasses, although widely distributed throughout the world in steppes and prairies, and of considerable economic importance, are only to be distinguished with difficulty and have not always been adequately described. This paper represents a large amount of work and it removes many difficulties. Seven new species are described, together with a number of new combinations.

VARIABILITY IN FUNGI.—Mr. H. R. Briton-Jones records the results of cultural work on *Rhizoctonia Solani* Kühn in the Transactions of the British Mycological Society, vol. 9, p. 200. This fungus is responsible for the "sore-shin" disease of cotton seedlings. A number of forms from Egyptian cotton, from Missouri, U.S.A, India, and also from English peas and potatoes, were examined and induced to produce the fertile stage, *Corticium vagum*, under culture. The various strains remained more or less distinct throughout the experiments, even when allowed to infect a common host plant. They showed, moreover, different physiological properties. Thus the foreign strains, unlike those from Great Britain, were unable to grow at temperatures of 5-8° C. The fungus grows best at the surface of moist, not dry, jellies, just as in Nature it attacks its host plants at the ground level where comparable conditions obtain.

AMERICAN CAMBRIAN GEOLOGY AND PALÆONTOLOGY.—The veteran American palæontologist, Charles Doolittle Walcott, although past the allotted span of life, is, we are glad to see, still ably carrying on the work begun in 1908 of describing the primary fossils of America, and has just brought out Part 9 of vol iv. of his "Cambrian Geology and Paleontology" (Smithsonian Miscell. Publicat., lxvii.). The present part deals with the Cambrian and Ozarkian Brachiopoda, as well as two new species of Cephalopoda and a new genus, Ozomia, of the family Technophoridæ, formerly considered to be Pelecypods, but now referred to Sars's order Notostraca. The Brachiopoda come principally from Alberta and British Columbia, with a few from various localities in the United States, and a small collection from Novaya Zemlya. These are fully set forth and systematically described, and include fifty new species and a new variety. There are twenty most excellent plates of figures based for the most part on photographs.

MIOCENE FORAMINIFERA.—The mere mention of Foraminifera at once recalls to mind the great triumvirate of Parker, Jones, and Brady, who laid the foundations of our present knowledge of the order, while Jones's pupil, C. Davies Sherborn, compiled a "Bibliography" and an "Index" unsurpassed at the time. Later, the work was carried on by F. Chapman, now in Australia, but the historiographers in this century of these fascinating but most puzzling little animals have been Heron-Allen and Earland, whose joint works are familiar and indispensable to all students. These authors have just published (Journ. R. Micro. Soc., 1924) an elaborate paper on the "Miocene Foraminifera of the 'Filter Quarry,' Hoorabool River, Victoria, Australia," which is to be regarded as a supplement to Chapman's "Study of the Batesford Limestone," that writer being unable to carry it on further. The material dealt with consisted of about half a pint of white organic deposit from the Filter Quarry, which its Foraminiferal contents show must have been laid down in a tropical sea at a depth of from 50 to 150 fathoms under conditions very similar to those existing at the present day round the northern coasts of Australia. A sample from the overlying marl, taken by Dr. T. S. Hall, indicated that, although laid down in about the same depth, it must have been deposited within the continental mud line. Altogether the authors fully describe two hundred and seventy species and varieties, nineteen of which are held to be new. The new and a few previously named species are amply figured on eight plates containing 118 figures.

KNOLL-REEFS AND THE CRAVEN FAULTS.—In their paper on "The Lower Carboniferous Succession in the Settle District" (Quart. Jour. Geol. Soc., vol. lxxx. pp. 184-273, 1924), Prof. E. J. Garwood and Miss Edith Goodyear discuss a number of outstanding problems that have hitherto awaited a satisfactory solution. It is shown that the whole of the succession north of the North Craven Fault belongs to the North-Western Province, and that in general the Middle Craven Fault may be taken as the southern limit of this province. To the south the beds show almost everywhere an abrupt change to the southern type of development. Structurally, however, the change is complicated by the occurrence between the faults of knoll-reefs which belong to the Southern facies, and by the presence of Yoredale rocks south of the Middle Fault. The knoll-reef limestone of the High Hills is of D_3 age and therefore cannot pass laterally into the D_1 limestone against which it abuts on the north. Although there is no other evidence of thrusting, it is suggested that the beds have been brought together by movement from the fractured southern area against the rigid and undisturbed northern block. Thrusting seems also to explain the abrupt change from Southern to North-Western facies. With regard to the origin of the knoll-reef structure, Marr's contention that limestones of any kind can be folded into knoll-like domes is fully substantiated. It is also shown that the typical knoll-reefs of the southern succession owe their form partly, as suggested by Tiddeman, to the original deposition of rich accumulations of organic remains, and partly to the accentuation of the quaquaversal structure by subsequent movements.

DISTRIBUTION OF PHILIPPINE EARTHQUAKES.—In the recently issued Bulletin for May 1922 of the Manila Weather Bureau, the Rev. M. Saderra Masó considers the distribution of earthquakes in the neighbourhood of Butuan (northern Mindanao), basing his conclusions on the records of six years. The average monthly number of earthquakes registered by a Wiechert seismograph at Butuan (1916–1921) is 90. The earthquakes originate in four principal seismic zones. In the first (30-50 km. from Butuan), the earthquakes come chiefly from a shallow centre in Butuan Bay. The second and most important

zone (80-160 km.) includes the whole central and deepest part of the Philippine Deep; the third (270-320 km.) contains the central and southern extension of the Agusan valley (a zone responsible for the great earthquakes of 1893, 1894, and 1911); and the fourth (380-500 km.) the unstable north-east portion of the Celebes Sea. The zone of minimum frequency (60-80 km.) embraces most of the eastern and central cordilleras, in the latter of which no sensible earthquake, so far as known, has ever originated.

SURVEYS IN SPITSBERGEN.—An article by Mr. R. A. Frazer in the *Geographical Journal* for September gives an account of some explorations carried out by him, in conjunction with Messrs. N. E. Odell and G. Milling and the late Mr. A. C. Irvine, in Central Spitsbergen in August 1923. Their object was to amplify and extend the preliminary survey made in that region in 1921. Landing at Duym Point in Hinlopen Strait, they crossed the island via the Chydenius range and Mount Chernichev to the head of Klaas Billen Bay. The area traversed, which lies to the south of the New Friesland ice-sheet, proves to be a region of complex topography from which the glaciers drain mainly to the east. A provisional map of this small area is published. It is based on photogrammetric work, but it must await the precise positions of the northern beacons of the Russo-Swedish Arc of Meridian surveys before a final version can be prepared. Only the approximate positions of these beacons have so far been published.

DISINTEGRATION OF RADIUM-C.—The September issue of the *Philosophical Magazine* contains an account of the experiments which have been made by Sir Ernest Rutherford and Dr. J. Chadwick to determine the origin and nature of the long range particles which appear from a source of radium-C. They find that the particles of range 9·3 cm. appear in equal amounts in vacuum, helium, oxygen, carbon dioxide and zenon, in whatever way the source is prepared and whether it is covered by a sheet of mica or silica or left uncovered. The paths of the particles as determined by a shadow method and as deflected by a magnetic field lead to the conclusion that the particles are α-particles arising from the disintegration of the radium-C, and are not due to the disintegration of the gas through which the α-particles pass. The same conclusion appears to be probable with regard to the particles of range 11·2 cm., and the two groups probably represent new types of disintegration of radium-C.

THE MEASUREMENT OF FEEBLE RADIOACTIVITY.—A method of measuring weak radioactivity by means of a photographic record of the drift of an electrometer, charged by the ionisation current produced by β- and γ-radiation, is described by Dr. G Hoffmann in the *Zeitschrift für Physik* of July 12. The ionisation chamber consists of a very open wire cage, the potential of which is kept at 240 volts, and containing an electrode connected to the electrometer. The cage is cleaned with acid and is contained in a brass box, from which the air can be pumped and replaced by carbon dioxide from a steel cylinder. The carbon dioxide, when fresh, contains no emanation. The whole apparatus is surrounded by thick lead cylinders, and the substance to be examined is powdered on a sheet of tinfoil covered with a thin layer of shellac, and placed in a holder round the inner surface of the brass box. All α-rays are absorbed by the carbon dioxide before they reach the cage, and so do not cause rushes of ionisation and irregularities in the photographic record. Among other experiments made with the apparatus, the radioactivity of sodium and cæsium has been studied; taking that of potassium as unity, sodium gives less than 0·002, and cæsium from polluxite, which contains no rubidium, shows no trace of radioactivity.

THE CRYSTALLINE STRUCTURE OF GRAPHITE.—In the *Zeitschrift für Physik* of August 4, Messrs. O. Hassel and H. Mark describe an investigation designed to clear up the discrepancy between the results of Debye and Scherrer and those of Hull; single crystals, natural and artificial, and polycrystalline material were employed, and great care was taken to avoid distorting the soft material, which, when in the form of powder, was not pressed into rods, but fastened with collodium to a thin wool thread, stretched in the axis of the camera. Different characteristic X-radiations were employed, and the rotation diagram method, the Laue method, Bragg's reflection method, and the Debye-Scherrer method were all made use of, the intensity relations of the reflections being determined. Consideration of the whole of the diagrams in detail showed that, if all the carbon atoms have the same valency, there is no space group which gives the observed interferences. It is necessary to assume a c-edge-centred lattice, with particles having the reflecting power R_1, shifted a certain amount with respect to a lattice with reflecting power R_2 and with the particles in the positions for closest packing; the smallest possible orthohexagonal cell measures $a = 2{\cdot}47$ Å, $b = 4{\cdot}25$ Å, $c = 6{\cdot}70$ Å, and contains eight atoms; a figure in the original paper shows the relations between the particles. The measurements of Ewald, Debye, Scherrer, and Hull agree with the structure determined.

GLASS TECHNOLOGY.—The Experimental Researches and Reports published by the Department of Glass Technology of Sheffield contains in volume 6, 1923, among other papers, one on natural sillimanite as a refractory material, by S. English, and one on heat-resisting glasses by Prof. Turner. The first paper gives an account of some trials of natural sillimanite, which melts at 1816°, in place of clay as a refractory. Mixtures with clay were used. The mixture with 9 per cent. of clay showed a very small shrinkage on drying, and on burning at 1400° the further contraction was negligible. The porosity was rather less than standard pot clay, and the action of molten glass was much less than that on clay. Prof. Turner's paper gives an interesting account of the developments in the manufacture of heat-resisting glasses, beginning with the systematic work of Schott at Jena in 1892, and including "Pyrex" glass containing 80·62 per cent. of silica, 11·9 of boric anhydride, 2 per cent of alumina, 3·83 per cent. of soda, and small quantities of other constituents. In America, tea and coffee pots, tea-cups, and cooking ware are made from refractory glass.

SODIUM TUNGSTATES.—We have received a reprint of a paper on sodium tungstates by Dr. E. F. Smith, published as a contribution from the John Harrison Laboratory of Chemistry, University of Pennsylvania. The sodium tungstates described in the literature were re-examined, and the conditions for preparing 5:12 sodium tungstate determined. With normal sodium tungstate (1:1) and meta-sodium tungstate (1:4) as opposites in basic and acid character, the intermediates 3:7, 5:12, and 4:10 were found as products of their union. The 1:2 and 1:3 salts do not exist, probably because of their very ready hydrolysis. The suggestion that paratungstates exist in two modifications, namely, 3:7 and 5:12, was not confirmed. Carbon tetrachloride as a new reagent was extensively employed.

The Japanese Earthquake of 1923.

SOON after the earthquake of September 1, 1923, the Imperial Earthquake Investigation Committee appointed a number of sub-committees to investigate the earthquake from different points of view, dealing with observations on seismology, geology, hydrography, and geodesy, and, on the practical side, with problems of architecture and civil engineering. The complete reports of the various sub-committees will, it is expected, be published before many months are over. In the meantime, Prof. A. Imamura, who has succeeded Prof. Omori as the head of the Investigation Committee, has written a valuable report which appears in No. 6 of the "Seismological Notes" of the Committee.

As Prof. Imamura points out, the earthquake was by no means the most severe that has visited the Japanese Empire—it was inferior, for example, to the Tokyo earthquake of 1855—though, in the destruction of life and property, it is probably without a rival. After five minutes, the motion had so far subsided that Prof. Imamura was able to visit the observatory of the Seismological Institute. Here he found that nearly all the instruments were wrecked. Only one component of one seismograph kept working all through the earthquake, but, within five minutes, four seismographs (recording actual size or up to twice that size) were readjusted or repaired, other more sensitive instruments being added after a day or two. These repairs were impeded by the outbreak of fire in the University, and it was not until 10 P.M.—the earthquake occurred just before noon—that the Institute and its observatory could be regarded as safe. The office of the Investigation Committee was burnt with its important papers.

From the direction and duration of the preliminary tremors, it is estimated that the epicentre was 92 km. from Tokyo in the direction S. 26° W., that is, under Sagami Bay, in lat. 34° 58·6′ N., long. 139° 21·8′ E. The angle of emergence at Tokyo was 10°, giving a depth of about 15 km. for the focus. The curve representing the relation between the focal distance and the time of transit of the first tremors is practically a straight line, from which it is found that the time at the origin was 11 h. 58 m. 32 s., and the velocity of the first tremors 7·5 km. per sec. for the neighbourhood of the epicentre. The total duration of the record of the great shock was 2 h. 20 m.

From the initial direction of the movement at different places within a radius of 170 km., Prof. Imamura concludes that "the seismic action might have been applied in such a manner that the compression along a deep stratum was directed towards the north and west."

The greater part of the coast of Sagami and Tokyo Bays was elevated, the maximum amount of uplift being a little more than 2 metres. Such changes are slight compared with the displacements in the bed of Sagami Bay. The total area of depression is estimated at 700 sq. km. and that of elevation at 240 sq. km., the total volume depressed at 50 c. km., and the volume elevated at 20 c. km. This implies that the average depression was 39 fathoms and the average elevation 45 fathoms.

The tsunami, or seismic sea-waves, were greatest along the shores of Sagami Bay, where they reached a height of 8 metres at Ito and Aziro, 9 metres at Ainohama, and 12 metres at Atami. From the directions in which the sea-waves advanced, it follows that the most prominent waves came from neighbouring areas of elevation. The enormous depressions gave rise to only minor waves.

The cause of the earthquake is still unknown. Possibly there may have been a great fault-movement in the heart of Sagami Bay, but so far no trace of it has been discovered. On land, two minor faults have been observed, one near Nagasawa in the Miura peninsula, the other near Nago in the Bo-so peninsula. Both are about 2 km. in length, and have a maximum vertical displacement of one metre.

Four slight shocks, with epicentres in or near Sagami Bay, were registered at Tokyo during the preceding month, the last one eight days before the earthquake. Otherwise, the great shock came suddenly and without warning. The study of the after-shocks is complicated by the great size of the focal area, and by the occurrence of another destructive earthquake, belonging to the same zone, and of nearly equal strength, at 2 h. 47 m. on September 2, the after-shocks of which mingled with those of the first earthquake. The after-shocks originated in three areas, the first including the Bay and Province of Sagami, the second the Bo-so peninsula and sea-bed to the east, and the third the drainage-area of the River Tone to the north of Tokyo. Of the 1256 after-shocks recorded at Tokyo during September, 46 (including the majority of the strong after-shocks) occurred in the first zone, 71 in the second, and 25 in the third, while the epicentres of more than a thousand (nearly all slight and none strong) are unknown.

The latest statistics show that the total number of lives lost was 99,331 (59,065 in Tokyo and 23,440 in Yokohama), 103,733 were wounded, and 43,476 missing. The number of houses completely collapsed was 128,266, while 126,233 half collapsed, 447,128 were burnt, and 868 washed away. A second table gives the number of houses collapsed in the places most severely damaged, and the percentage of such with regard to the number of pre-existing houses. In Yokohama the percentage was as low as 12·4, but in Kamakura it rose to 84·4, and in six places it exceeded 90. In one of these (Simosoga) it was 97·8.

A recent issue of the Bulletin of the Seismological Society of America (vol. 13, 1923, pp. 124-146) contains an interesting article on the Japanese earthquake by Dr. T. A. Jaggar, the well-known vulcanologist and founder of the Volcano Observatory on Hawaii. Dr. Jaggar spent October in the meizoseismal area, and he has added many details to our knowledge of the earthquake. He estimates the value of property destroyed at between four and five thousand million dollars, and states that some well-informed Japanese put the loss of life at about four hundred thousand. The volcano of Oshima showed no unusual phenomena at the time of the earthquake. Dr. Jaggar describes the changes of level of the floor of Sagami Bay and along the coast-line. These are summarised above and in NATURE, vol. 113, pp. 473-474. He considers that the belt of maximum depression was the epicentral tract. "As the shoreline belts all about were lifted or lowered only one to eight feet, the depression mechanism was of a different order from the margin mechanism. It appears to have been a collapse of blocks into a pit or rift in the bottom of the bay aligned with the island volcano chain, which extends hundreds of miles south-southeast." The after-shocks were of two kinds, the slow prolonged type (resembling the first shock) and the abrupt short type preceded by a booming noise. Dr. Jaggar quotes at length the accounts of several careful observers in Tokyo, Yokohama, etc. With regard to the place of the earthquake among other great shocks, he concludes that it was not more intense than the Mino-Owari (Japan) earthquake of 1891, and probably much weaker than the Yakutat Bay (Alaska) earthquakes of 1899.

C. D.

Standardisation of Scientific Glassware.

THE Joint Committee for the Standardisation of Scientific Glassware, which was promoted by the Institute of Chemistry (30 Russell Square, W.C.1), and includes thirty-seven members representing mainly users and manufacturers, has published its first report, entitled "Units of Volume," in which is recorded the unanimous recommendation to discard the cubic centimetre as the standard unit for scientific glassware and to institute therefor the litre and the millilitre. Since, however, some chemists still prefer to use the Mohr unit, the Committee has added two further recommendations to obviate confusion between the two systems, although it hopes that in time the litre and the millilitre will be adopted exclusively. Vessels graduated on the Mohr system, it is recommended, should be marked "G.W.A." (grammes of water in air), and the numerical relation between the units shall be 1000 G.W.A. = 1002 ml. The National Physical Laboratory will test vessels of both kinds, but those graduated on the Mohr system will be marked differently from the others.

Whereas the volume of a body of simple geometrical form is readily calculated from its linear dimensions, the volume of a hollow vessel designed to hold a fluid is determined more easily and more accurately by finding the weight of water required to fill it. But the use of two distinct types of units has many disadvantages, especially if there is no simple numerical relation between them. To establish such a relation, the originators of the metric system defined the kilogram as the mass of water which occupies one cubic decimetre at its temperature of maximum density; so that the unit of volume, the litre, could be defined either as a cubic decimetre or as the space occupied by a kilogram of water at the specified temperature. A cubic decimetre of water was, however, not a practical standard weight, and the kilogram was therefore re-defined as the mass of a particular standard weight (*kilogramme des Archives*). In accordance with this change, the litre was re-defined as the volume occupied by one kilogram of pure water at its temperature of maximum density and under normal atmospheric pressure. Thus the litre became independent of the metric unit of length, and the cubic centimetre lost its relation to the volume of a mass of water. The precise relation between the litre and the cubic centimetre was found experimentally to be 1 litre = 1000·027 c.c. (± 0.001), a difference so small as to be negligible for ordinary volumetric glassware.

The introduction of the Mohr system caused confusion, inasmuch as by it the unit volume was defined in terms of the apparent weight in air of a mass of water at room temperature. By this system a "litre" flask contains 1000 gm. of water (weighed in air against brass weights) at 17·5° C., which is the equivalent of 1002 c.c. as defined above; but the followers of Mohr designated the volume occupied by the 1000 gm. of water one litre, and the thousandth part of it one cubic centimetre. The exact relation between the Mohr unit and the millilitre is given by the fact that the amount of water which weighs 1000 gm. in air of density 0·0012 gm./ml., when weighed against brass weights of density 8·4 gm./ml., occupies a volume of 1002·021 ml. at 60° F. The difference between this figure and 1002, namely, 2 parts in 100,000, is negligible in practice, and hence the Committee recommends the adoption of the round number, thus facilitating inter-conversion of "G.W.A." and millilitres.

The Committee has also considered the accuracy of volumetric glassware, and recommends the adoption of only two grades, namely, Class A, or Standard Apparatus, which must pass the N.P.L. or other approved test, and the Class B, or Commercial Grade Apparatus, of cheaper quality and for general use, which must, however, be guaranteed by the manufacturer to comply with certain minimum requirements. The Class A Tests and the Class B Tests of the National Physical Laboratory (as revised in a recent pamphlet to be obtained from The Director, N.P.L., Teddington, Middlesex) are approved, and confidence is expressed that manufacturers will be able to supply guaranteed Class B apparatus at reasonable prices. Finally, the Committee urges strongly that volumetric glassware should never be ordered without specifying the limits of accuracy required.

Cod and Cod Fishery.

THE three papers included in No. 7, vol. vi., series ii., Fishery Investigations, Ministry of Agriculture and Fisheries (H.M.S.O., price 3*s*.), record an investigation undertaken as part of the general programme of research on the cod which was initiated by the International Council for the Exploration of the Sea in 1921.

The first, under the initials of Mr. W. C. Smith, deals with the Irish Sea cod fishery. This fishery is of importance only during the winter months, and it is carried on chiefly by Manx long-line fishermen and a few Fleetwood steam-liners. With the approach of winter and the decreasing temperature of the water, large mature cod move into the Irish Sea from the north to spawn. The return movement begins in April and is usually completed by the end of that month. Spawning takes place during February, March, and April in the waters around the Isle of Man and off the Cumberland coast. The young immature fish remain in these waters throughout the year.

The second paper, by Prof. Jas. Johnstone, gives an account of the cod as a food fish. It contains a summary of most of the results of analyses of cod and cod products, which may be found in König's big volume and in the work by Atwater. The results obtained from Irish Sea cod are also included. The results show that the cod is a "fat-poor" fish. Less than about half of the total weight of the entire fish is edible. In the edible substance, about 81 per cent. to 84 per cent. is water, and there is practically no fat; about 1 per cent is ash, and the rest (about 14 to 17 per cent.) is protein.

The third paper, by Prof. Johnstone and Mr. A. Scott, summarises information on the parasites and diseases of the cod. Ectoparasites and endoparasites are set out under orders and families, and a note on the occurrence of each is given. Both are less numerous in the cod than in many other species of fishes. The whiting and haddock, for example, are much more affected than is the cod. Cases of sarcomatous and other tumours, lupus and ulceration of the body, "columnar disease" in the muscle, diseased liver, stone in the urinary bladder, and ovarian degeneration are on record. Humpbacked cod in which the head is fairly normal in shape, while the trunk and tail regions are shortened and the backbone is thrown into a gently spiral form, are occasionally seen. One-eyed cod suggestive of irregular development rather than of injury are also recorded. References to literature on hermaphroditism are given in the concluding section of this instructive paper.

University and Educational Intelligence.

ABERDEEN.—Prof. Alex. Findlay has accepted an invitation to visit Stanford University, California, as acting-professor of chemistry for the three-quarters of the academic year, January to August, 1925.

LEEDS.—The University and the Philosophical and Literary Society have arranged a joint programme of lectures and music for the autumn term. The lectures include one by Prof. L. Bairstow on some aspects of modern aerodynamics, one by Mr. J. S. Huxley on recent progress in developmental physiology, and three by Prof. A. Gilligan on the geology of Yorkshire, all of which are free. Prof. S. Brodetsky and Mr. S. Stoneley are giving a popular course of six lectures on astronomy and Prof. P. F. Kendall three lectures on man and the ice age.

LONDON.—The two following courses of free public lectures at King's College are announced:—On Wednesday, October 8, and seven successive Wednesdays, at 4.30, "The Histology of the Nervous System," by Dr. C. da Fano; on Wednesday, October 8, and four following Wednesdays, at 5.30, "The Human Body and its Function," by Prof. R. J. S. McDowall.

On Friday, October 3, at 5 30 P.M., Prof. T. Percy Nunn will deliver a free public lecture at University College on "The Scientific Interpretation of Nature" This lecture is introductory to the new course for the M.Sc. on the principles, history, and method of science.

APPLICATIONS are invited for the headship of the chemistry department of the Borough Polytechnic Institute. Particulars and a form of application are to be obtained from the principal of the Institute, Borough Road, S.E.1.

IT is stated in the *Times* that schools of forestry are to be established at the University Colleges of Auckland and Canterbury by the New Zealand Government, which will make a grant of 1000*l*. a year, with an additional 600*l*. towards the cost of initial equipment.

INDIAN education in 1922–23 is reviewed by the Educational Commissioner with the Government of India in a report recently published at Calcutta. Commenting on the reorganisation of the University of Allahabad, the report states that some dissatisfaction has been expressed with the arrangement by which a residential teaching university is combined with affiliated colleges, some of which are situated at places very far distant from the university centre. This has led to movements for the establishment of universities at Agra and in Rajputana.

WE have received a "London University Guide and University Correspondence College Calendar, 1924–25," issued by University Correspondence College, Burlington House, Cambridge. This is a handy little volume of 200 pages, giving in convenient form regulations, syllabuses, and advice as to appropriate text-books for preparation for the matriculation and external degree examinations of the University of London. It is issued gratis. It was formerly published annually, but its issue has been suspended since 1915.

THE London County Council recently opened an education publicity campaign by issuing an excellent little pamphlet entitled "The Londoner's Education." This has now been followed by a sixpenny "Guide to Continued Education in London," this being No. 1 of a "Privileges of Citizenship" series. In addition to giving a concise account of the provision made for continuation education of all types—commercial, technical, trade, domestic, literary—and of the facilities available for all classes of students for improving their knowledge and using profitably their leisure hours, the booklet gives lists of numerous pamphlets, obtainable, most of them gratuitously, at the Council's offices, which contain more detailed information. It gives also a convenient list of several hundreds of institutions offering evening classes.

THE Ministry of Agriculture and Fisheries and the Board of Agriculture for Scotland are inviting applications for a limited number of agricultural scholarships, of a maximum annual value of 200*l*., which are open to students proposing to take up posts as agricultural organisers, teachers or lecturers in agriculture, etc. Candidates should usually be graduates of a university. The scholarships are tenable for two years, and are intended to give students an opportunity of broadening their knowledge of agriculture both at home and abroad. Their value will vary according to the scholars' means, and to the cost of living prevailing in the country visited; laboratory fees and travelling expenses will be defrayed. Particulars may be obtained from the Secretary, Ministry of Agriculture and Fisheries, 10 Whitehall Place, London, S.W.1, in the case of English and Welsh students, and from the Secretary, Board of Agriculture for Scotland, York Buildings, Queen Street, Edinburgh, in the case of Scottish students. The latest date for receiving applications is October 31.

THE Industrial Fellowship scheme of the Mellon Institute of the University of Pittsburgh has been in operation for thirteen years. A recent report of the director shows that at the close of the year 1923–24 no fewer than 83 research chemists and engineers were employed at the Institute, and that the sum of 412,132 dollars had been contributed for sustaining this work by the industrial fellowship donors. The total amount of money given by industrial firms to the Institute since 1911 is 2,719,103 dollars. The history and research system of this unique institution are described in an illustrated booklet, which also contains one of the forms of agreement under which fellowship foundations are accepted. The salient features of the system are as follows: A firm or an association of manufacturers having a problem or group of problems that needs investigation, provides a sum of money (about 5000 dollars for each investigator to be employed for a whole year) sufficient to cover salaries of investigators, operating charges, and purchase of necessary equipment; the Institute selects the fellow or fellows, and furnishes laboratory, library, consultative facilities, the use of its permanent research equipment, direction to the progress of the work, and an environment that stimulates productive investigation; all results are the property of the donor, to whom in the meanwhile monthly progress reports are regularly submitted. Although primarily an industrial experiment station, the Institute recognises the need of fundamental scientific research as a background and source of stimulus for industrial research, and has funds which are devoted to the prosecution of investigations not suggested by industry but planned by the permanent staff, four of whom were engaged in purely scientific research of this type during the year. Co-operation between the fellows is stimulated by a social club, in the activities of which all are expected to take part.

Early Science at the Royal Society.

September 27, 1662. The president communicated a letter sent by his majesty to the duke of Ormonde, lord-lieutenant of Ireland, recommending the Royal Society for a liberal contribution from the adventurers and officers of Ireland for the better encouragement of the said society in their designs. Whereupon it was ordered that a copy of the said letter should be taken; and the humble thanks of the society be returned to his majesty by Sir Robert Moray, for this great testimony of his royal favour.—The president was desired to return likewise the thanks of the society to Mr. Secretary Nicholas and Mr. Williamson, for their readiness to assist the society in the king's letters to Ireland without taking fees.

September 28, 1664. There was read a letter of Dr. Wallis to Mr. Oldenburg, giving an account of his having performed the task imposed upon him concerning Mr. Horrox's astronomical papers, by comparing the copies with the originals, and digesting all the several pieces into one body, and prefixing to it an epistle addressed to the president of the Society.—The secretary informed the Society that at Rome observations of Jupiter had lately been made with the new glasses of Campani, by means of which, six belts had been discovered in that planet, four of which had appeared more obscure, and two more clear than the rest of his body.—The secretary having also formerly written to his correspondents in France, to inquire into the truth of the odd experiment delivered by the jesuit Casati, in his book, intituled, "Terra machinis motu," and received an answer thereto by a person who had consulted the author of the book himself concerning the same, he communicated it to the Society; the substance of which was that the said Casati had not tried the experiment himself, but had seen it tried by a gentleman, named Don Innocenzo Conti, viz., that the liquor extracted out of a certain bismutum, and well rectified, when sealed up hermetically, and exposed to the moon, rose in the full, and fell in the new moon.

September 30, 1663. Mr. Palmer presented the Society, from Mr. Edward Diggs [Digges] with two sorts of silk, one coarse, the other fine, sent from Virginia, and made there; together with some written observations of Mr. Diggs' concerning silk-worms, and the making of silk, contrary to the received opinion thereof. Mr. Palmer was desired to return the Society's thanks to the presenter, and to let him know, how much they were pleased with his care and concern for improving of this manufacture, and how glad they should be to receive information, from time to time of the progress of it. Mr. Hill was desired to get the parcel of the coarser silk to be put into a stuff for a cover for the mace.

1674. Mr. Hooke reported, that upon his making the proposal of the council to Mons. Papin of twenty pounds a year certain for writing all letters for the Society, he had accepted the same.

October 1, 1662. Dr. Wren presented some cuts done by himself in a new way of etching; whereby, he said, he could almost as soon do a piece on a plate of brass, as another should draw it with a crayon on paper.—Dr. Merret read his paper concerning the planting and preserving of timber; together with his collection of those statutes, that have been formerly made by the parliament of England.

October 3, 1666. The lord bishop of Exeter being requested to communicate the observations of Jupiter's satellites made by Mr. Laurence Rooke in order to the calculating of tables of their motion, his lordship desired, that he might be put in mind of it by Mr. Hooke, and that he would purposely come to his library in Gresham College to look them out.

Societies and Academies.

London.

The Institute of Metals (Autumn Meeting), September 9.—R. J. Anderson and E. G. Fahlman: A method for measuring internal stress in brass tubes. The method for measuring longitudinal internal stress is called the strip method, and is carried out by slitting a narrow strip longitudinally in a piece of tubing; for example, a strip 2·75 inches long and 0·10 inch wide in a 3·25 inch tube length; and then releasing one end of such a slit strip by cutting. Stress is indicated by the springing out of the freed end, and can be calculated from the modulus of elasticity of the material and the distance in movement of the freed end.—D. H. Andrews and J. Johnston: The application of the ideal solubility curve to the interpretation of equilibrium diagrams in metal systems. The method of plotting here discussed has not been applied previously to metal systems. In many systems the simple theory fits the observations better than had been anticipated, and may at least be used as a guide in criticising and simplifying experimental work.—Guy D. Bengough and R. May: Seventh report to the corrosion research committee of the Institute of Metals. The problem of corrosion is considered largely from the point of view of the "scale" of corrosion products which forms on the surfaces of such metals as copper, zinc, and brass immersed in sea-water. A large proportion of tube failures in modern condensers is due to local impingement of aerated sea-water; the rapid corrosion is due to the local removal of protective scale by the impinging stream Certain types of preformed scales may be very resistant to this type of action. The occurrence of "dezincification" is due, not to bad mixing of copper and zinc in the manufacture of brass, but to the absence of arsenic from tubes. The electrolytic method of protection of condenser tubes generally gives negative results, but occasionally good results have been reported; these seem to be due to chance secondary effects particularly of the anode products. Corrosion of brass may be due to metal-ion concentration cells or oxygen-distribution cells. With high-speed water streams the metal-ion concentration cell may become the more powerful and render the metal anodic and severely corroded; deposits of sand, porous masses of corrosion products, etc., may cause oxygen distribution cells to become active and set up local corrosion, but the most rapid cases of corrosion seem to belong mainly to the former type. Sometimes the two types of action reinforce one another.—E. H. Dix, Jr., and A. J. Lyon: Comparative results on copper-silicon-aluminium and other aluminium alloys as obtained on separately cast specimens and specimens cut from a crankcase casting. Copper-silicon-aluminium alloy is particularly well adapted for complicated castings which do not require a large amount of machining. The casting properties of Alpax are similar, but it has a very low proportional limit and is inferior in this respect. Lynite 195 has uniform and desirable physical properties. The proportional limit is considerably above any of the alloys tested. The foundry practice, however, is more difficult for this type of an alloy. 8 per cent. copper-aluminium alloy is suitable for the general run of castings and can be cast in sections $\frac{3}{16}$ in. or more in thickness without much difficulty.—R. Genders: The extrusion of brass rod by the inverted process. Precautions are necessary to secure good surface, the method adopted for the present being the avoidance of entrance of the skin of the billet into the region of flow. The structure of the extruded rod does not show the concentric zones of

material varying in crystal size and physical properties often produced by the peculiar nature of the flow which obtains in the ordinary process. The rear portion of the rod is variable in structure and hardness from centre to outside, but in a continuous gradient. All possibility of "core" defect is excluded, and, if defects are allowed to arise, they will be visible on the surface of the rod.—D. **Hanson** and Grace W. **Ford**: Investigation of the effects of impurities on copper. Part II.—The effect of iron on copper. Solid copper will dissolve about 4 per cent. of iron at 1100° C., but the solubility at lower temperatures is much less. Within the limits of solid solubility, the electrical resistivity increases rapidly as the iron content is raised: hence iron is extremely deleterious in copper for electrical purposes. The tensile strength is raised by 2 per cent. of iron from 14·5 tons per sq. in. to about 20 tons per sq. in. The effect of heat-treatment is relatively small. Iron has no great embrittling effect.—Sir Thomas K. **Rose** and J. H. **Watson**: Experiments on the working of nickel for coinage. The experiments were made in order to determine the conditions in which nickel for coinage could be cold-rolled in the existing rolls at the Royal Mint. It was found impossible to prepare coins containing 99 per cent. nickel with 1 per cent. of manganese, magnesium, carbon, iron, silicon, etc., such as are manufactured with the aid of hot-rolling. By the addition of 2 per cent. manganese, however, castings can be prepared suitable for cold-rolling and conversion into coin. The coins consist of a solid solution, and accordingly resist tarnishing and corrosion equally well with those containing 99 per cent. or more of nickel, such as are in circulation abroad.

Official Publications Received.

Transactions of the Leicester Literary and Philosophical Society; together with Report of the Council for 1923-1924 and Annual Reports of the Sections. Vol. 25, 1924. Pp. 55. (Leicester.)

Far Eastern Association of Tropical Medicine. Transactions of the Fifth Biennial Congress held at Singapore, 1923. Edited by the Hon. Dr. A. L. Hoops and Dr. J. W. Scharff. Pp. 974+86 plates. (London: J. Bale, Sons and Danielsson, Ltd.) 40s. net.

Memoirs of the Asiatic Society of Bengal. Vol. 8, No. 2: The Prakrit Dhātv-ādeśas according to the Western and the Eastern Schools of Prakrit Grammarians. By Sir George Abraham Grierson. Pp. 77-170. (Calcutta.) 3.15 rupees.

The Rockefeller Foundation: International Health Board. Tenth Annual Report, January 1, 1923-December 31, 1923. Pp. xvii+158. (New York: 61 Broadway.)

Proceedings of the Academy of Natural Sciences of Philadelphia. Vol. 76: Studies in the Dermaptera and Orthoptera of Ecuador. By Morgan Hebard. Pp. 109-248+plates 5-10. (Philadelphia.)

Government of India. Department of Industries and Labour: Public Works Branch. Irrigation in India: Review for 1922-1923. Pp. iv+39. (Simla: Government of India Press.) 12 annas.

Forest Bulletin No. 58: General Volume Table for *Chir* (*Pinus longifolia*). Classified by Diameter (and Girth) and Height. By S. H. Howard. Pp. 14+3 plates. (Calcutta: Central Publication Branch.) 8 annas.

Report on the Danish Oceanographical Expeditions 1908-10 to the Mediterranean and Adjacent Seas. Vol. 2: Biology H 1: Medusæ. By P. L. Kramp. Pp. 67. (Copenhagen: Andr. Fred. Høst and Søn.)

The Hundred and Second Report of the Commissioners of His Majesty's Woods, Forests, and Land Revenues. Pp. 50. (London: H.M. Stationery Office.) 6s. 6d. net.

Prospectus of University Courses in the Municipal College of Technology, Manchester, Session 1924-25. Pp. 229. (Manchester.)

Meddelanden från Statens Skogsforsöksanstalt. Häfte 21, Nr. 4: Några Norrländska Skogsforyngringsproblem II; Quelques problèmes relatifs à la régénération dans la Suède septentrionale II. Av Gunnar Schotte. Pp. 149-180. Häfte 21, Nr. 5: Tallens och granens Kolsyreassimilation och dess Ekologiska Betingelser; Untersuchungen zur Ökologie der Kohlensäureassimilation der Nadelbäume. Av M. G. Stålfelt. Pp. 181-258. Häfte 21, Nr. 6: Skogsinsekternas Skadegörelse under åren 1919-1921; Die Schädigungen der Forstinsekten in den Jahren 1919-1921. Av Ivar Trägårdh. Pp. 259-291. (Stockholm: Centraltryckeriet.)

Loughborough College, Leicestershire. Calendar, Session 1924-25. Pp. xiv+214+53 plates. (Loughborough.) 3s. 6d. net.

Transactions of the Institution of Chemical Engineers. Vol. 1, 1923. Pp. xv+120. (London: Abbey House, Westminster.)

Manchester Astronomical Society. Journal of the Sessions 1922-1924. Pp. 60. (Manchester.) 4s.

Growth in Trees and Massive Organs of Plants. Dendrographic Measurements, by D. T. MacDougal; The Growth Record in Trees, by Forrest Shreve. (Publication 350.) Pp. 116. (Washington: Carnegie Institution.) 1.50 dollars.

Department of Marine Biology of the Carnegie Institution of Washington. Vol. 20: American Samoa. Part 1: Vegetation of Tutuila Island; Part 2: Ethnobotany of the Samoans; Part 3: Vegetation of Rose Atoll. By Prof. William Albert Setchell. (Publication 341.) Pp. vi+275+37 plates. (Washington: Carnegie Institution.) 3.50 dollars.

The Vesuvius Eruption of 1906: Study of a Volcanic Cycle. By Frank A. Perret. (Publication 339.) Pp. 151+24 plates. (Washington: Carnegie Institution.) 4 dollars.

Natal Museum. Mammals, Series 1. 10 pictorial post cards and leaflet. Mammals, Series 2. 10 pictorial postcards and leaflet. (Pietermaritzburg.)

Year Book of the Michigan College of Mines, 1923-1924, Houghton, Michigan. Announcement of Courses, 1924-1925. Pp. 123. (Houghton, Mich.)

Department of Commerce: Bureau of Standards. Technologic Papers of the Bureau of Standards, No. 259: Saturation Relations in Mixtures of Sucrose, Dextrose, and Levulose. By Richard F. Jackson and Clara Gillis Silsbee. Pp. 277-304. (Washington: Government Printing Office.) 10 cents.

Bulletin of the American Museum of Natural History. Vol. 49, Art. 3: The Dermaptera of the American Museum Congo Expedition; with a Catalogue of the Belgian Congo Species. By James A. G. Rehn. Pp. 349-413. Vol. 49, Art. 4: Size-Variation in Pyrenestes, a Genus of Weaver-Finches. By James P. Chapin. Pp. 415-441. Vol. 49, Art. 5: Observations on *Colobus* Fetuses. By Adolph H. Schultz. Pp. 443-457. (New York.)

Marine Structures: their Deterioration and Preservation. Report of the Committee on Marine Piling Investigations of the Division of Engineering and Industrial Research of the National Research Council. By William G. Atwood and A. A. Johnson; with the Collaboration of William F. Clapp, of Robert C. Miller, and of H. W. Walker, H. S. McQuaid and Marjorie S. Allen. Pp. vi+534+14 plates. (Washington: National Research Council.) 10 dollars.

Diary of Societies.

SATURDAY, SEPTEMBER 27.

SCHOOL NATURE STUDY UNION (Anniversary Meeting) (at London Day Training College), at 3.—G. H. Gater: Address.

TUESDAY, SEPTEMBER 30.

INSTITUTE OF MARINE ENGINEERS, at 6.30.—J. Lamb: Marine Oil Engines, Practical Notes on Bearing Adjustment.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—Dr. G. H. Rodman: A Talk about Orchids.

WEDNESDAY, OCTOBER 1.

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (at Chemical Society), at 8.—G. D. Elsdon and P. Smith: The Determination of Coconut Oil and Butter Fat in Margarine.—F. Knowles and J. C. Urquhart: A Preliminary Note on the Composition of the Fat of Goat's Butter.—Miss W. N. Nicholson and D. Rhind: The Quantitative Estimation of the Degree of Hydrolysis of Gallotannin by Tannase.—Miss M. B. Richards and W. Godden: The Pemberton-Neumann Method for the Estimation of Phosphorus.—W. S. Shaw: Application of "Formal Titration" to the Kjeldahl Method of Estimating Nitrogen.

THURSDAY, OCTOBER 2.

INSTITUTION OF MINING ENGINEERS (Annual General Meeting) (at British Empire Exhibition), at 11 A.M.—Dr. J. S. Haldane: The Values for which the Institution stands (Presidential Address).—Sir Josiah Court: Salt Treatment for Miners' Fatigue.—Prof. K. Neville Moss: (a) The Food Requirements of Coal Miners; (b) The Mechanical Efficiency of the Human Body during Work in High Air Temperatures; (c) The Physiological Standardisation of the Kata-Thermometer.—J. T. Storrow and J. Ivon Graham: The Application of Gas Analysis to the Detection of Gobfires.

ROYAL AERONAUTICAL SOCIETY, at 5.30.—Lt.-Col. H. T. Tizard: Common Sense and Aeronautics.

CHILD-STUDY SOCIETY (at Royal Sanitary Institute), at 6.—Miss Ida C. Ward: Speech Defects.

FRIDAY, OCTOBER 3.

INSTITUTION OF MINING ENGINEERS (Annual General Meeting) (at British Empire Exhibition), at 10.30 A.M.—E. Williams: Economics of the Coal-mining Industry.—R. L. A. Dron: The Valuation of Mines and Minerals, and the Relation of Income Tax to such Valuations.—Prof. D. Hay and R. Clive: The Ventilation of Mines.—E. L. Hann: The Rhymney Valley Compressed-air Installation.—S. Mavor: Problems of Mechanical Coal-mining.—F. S. Sinnatt and H. E. Mitton: The Preparation of Coal for the Market.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—Display of Exhibition Slides.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—Prof. A. W. Bickerton: Explosions, Terrestrial and Celestial.

PUBLIC LECTURES.

THURSDAY, OCTOBER 2.

UNIVERSITY COLLEGE, at 2.30.—Sir Flinders Petrie: The Official Classes of Ancient Egypt.

FRIDAY, OCTOBER 3.

BEDFORD COLLEGE FOR WOMEN, at 11 A.M.—Miss Hosgood: The Netherlands.

UNIVERSITY COLLEGE, at 5.30.—Prof. T. Percy Nunn: The Scientific Interpretation of Nature.